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THE

PROSPECTOR'S MANUAL,

FOR THE

Discovery of Quartz and Placer Indications

OF

GOLD AND SILVER MINES

ALSO,

A Description of Mineral-Bearing Rocks; Indications of the Mineral Districts in all the New-England States and the Neighboring Provinces; the Characteristics of California, Nevada, and other Mines; Simple Methods of Assaying Gold and Silver Ores; and a Glossary of Scientific and Technical Terms.

By W. J. SCHOFIELD.

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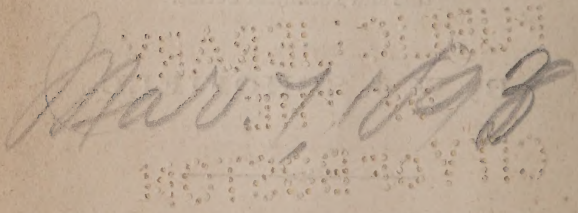

PREFACE.

The interest taken at the present time in relation to mining matters not alone in Essex county, but throughout the State, and in New Hampshire and Maine, particularly on the line of discoveries, is a sufficient justification for a little work on the subject which may be useful to owners of supposed mineral lands and to all others who may desire information in relation to such matters. The compilers disclaim any disposition to create an excitement, or to increase that which exists in relation to mining. They would rather seek to direct inquiries and researches into proper channels, and save men from wasting their labors in vain attempts to find mineral where there is none. That there is a large amount of mineral wealth hidden beneath the surface of the ground in New England cannot be doubted. The only question is whether the product which may be realized will pay for the labor and capital which is required in obtaining it. The eminent geologists who made the early surveys of the several New England States indicated many of the discoveries which would be made, but were very cautious in not holding out great expectations.

Large tracts of gold fields were known to exist in Vermont and New Hampshire, and by recent surveys they have been found greater than they were formerly supposed to be. In this little manual it has been the aim to show under what conditions the various kinds of the precious metals may be found, to indicate where discoveries have been made, enable every man to judge of the character of the minerals he may find, while he may avoid imposition, and learn the methods of analysis. Appended are descriptions of some of the most noted mines of this and other countries, with a glossary of terms used in mineralogy. Every thing that is of interest in connection with the subject, and necessary to be known, it is believed may be found in this work, brief as it may be, and if every one who seeks for mineral wealth does not realize his expectations in obtaining that wealth, he will at least have gained much knowledge in relation to the structure of the earth and of its resources, a subject upon which most men are lamentably deficient.

INTRODUCTION.

The information in this manual is intended to guide the prospector in his search for minerals, and especially to point out the indications of gold and silver in the New England States. The 'characteristics' of the gold and silver mines of California and Nevada, and of other States and territories and Mexico, commencing on page 69, will be found suggestive and valuable for reference. That ores of gold and silver are known to exist in the New England States is as true as that they were also known to exist in California, from whose placers a limited quantity was annually washed; but the conservative feeling and fear that repressed this knowledge in the early history of the golden State, through what was thought by the Spanish fathers the demoralizing consequences of their being prominently advertised to the world, also influenced one of the most thorough and scientific geologists and mineralogists of New England from announcing this knowledge of the precious ores in our midst except with deprecating language, fearing that it would draw away from what are denominated legitimate callings many persons whose moral teachings and experiences would

suffer from the excitement consequent on the success of the discovery, and that the country would eventually gain nothing in wealth by the transfer of regulated labor into such doubtful channels. That this view was fallacious is proved by the twenty-seven years' growth of California and Nevada especially, with the vast product of their auriferous and argentiferous wealth, enriching themselves and the world,—leaving these States today with a currency of gold and silver, in marked contrast with that of the rest of our country. Mining has grown to be as legitimate as any other business, its success depending on the same qualities that ensure competency and wealth in any other calling; and its failures and losses can be traced to the same inexperience and recklessness that eventuate in lack of success in the standard lines of business. An industry that requires the mechanical and scientific knowledge that regular mining requires cannot justly be said to be inimical to good habits or morality. The want of accurate topographical geological knowledge of the surrounding country is indicated by the mineral discoveries made almost daily,—none of which are indicated in the State reports,—some the result of search consequent on the recent discoveries at Newbury, and others the result of accident. It has seemed absurd to expect valuable ores and minerals in a country noted for rocks and ice, but when we consider

the nature of the country between the Rocky mountains and the Sierra Nevadas, which is so desolate and sterile that a traveller once expressed the opinion that if the above ranges of mountains were to come together and obliterate from existence the intervening region, nothing would be lost, we certainly have some hope of success in New England. The particles of gold picked up on Sutter's farm in California in 1848 have eventuated since then in the enormous yield of bullion of about $1,000,000,000 for California, and not less than $230,000,000 for Nevada, besides the additional mineral wealth obtained from the other territories and States through the agency of the original discovery. Many of the most profitable mines were brought into notice accidentally, of which the following are a few. The Oneida in California was discovered by a hunter who chased a rabbit to some large quartz croppings, in which he found rich specimens of gold; the Hinckley was first struck in digging a cellar; the Woodside was the result of prying up a piece of rusty rock that outcropped, the underside of which was speckled with gold; the Valenciana, in Mexico, was first discovered by a young Spaniard, who, after many privations, at last struck an immense body of ore, from which alone was extracted from 1787 to 1791 the sum of $14,764,492 out of 134,288 tons of silver ore; the Comstock lode, in Nevada, which has produced about

$200,000,000 of silver, was discovered by an attaché of a stage station while hauling wood from the hillside; and one of the most noted mines of Sinaloa, in Mexico, was discovered by a pious ranchero, who, losing his rosary, remained in the mountains during the night searching for it. Having made a fire to protect himself from the cold, in the morning he beheld the stones on which he had rested his wood sparkling with silver. But to the keen eye and experienced instinct of a trained gold and silver prospector the 'signs' and 'indications' are almost infallible,—the trend of mountains; the presence of tellurets in quartz, which contains crystals of feldspar and carbonates of lime and iron, when the speedy appearance of ore may be relied upon; the knowledge to distinguish between the different kinds of pyrites; the manner of inspecting quartz croppings to discover 'pockets,'—one of which yielded in a day, near Iowa Hill, California, to two men $30,000; the rounded and dome-like appearance of mountains, abraded through countless ages, from which the gold has been washed down into placers; smooth, well rounded hills and beds of gravel, either near a stream, or on the side or top of a hill; quartz veins and boulders; the beds and bars of ancient streams, especially where a ridge of rock extends across the channel, and where the gravel is shallow; or beds of streams which run dry in summer,—which

renders examination easy; to follow float quartz or other indications to the veins; to know how to wash gold and detect the minutest particles of mineral. These are some of the indications which naturally attract the practical miner. Experience teaches that any mountain not volcanic is likely to contain valuable metalliferous veins. They are found in rough and high mountain cliffs, but not so abundantly as in those with smooth outlines. Sometimes gold has been found under very anomalous conditions, for instance, that in the Cherokee mine, California, where the whole vein was decomposed and carious, and from which the discoverers took out $27,000 worth of gold, and then sold it to others who got $9,000, then leased it to a gentleman who obtained $30,000, and after him came a party who took out $25,000 more. But that at Meadow Creek was singularly remarkable. The deposits of gold were in a marsh on the top of a mountain, in the centre of a basin. The depression was nearly circular, about twelve miles in diameter, and surrounded by high mountains, except in an opening to the south. The mountain on which this mine is situated is granite, nearly circular at its base, and is about 1000 feet high. From its top a number of flat, marshy ravines ramify in every direction. Under this was a stratum of rough, unwashed gravel, which contained very rich gold, the best gravel yielding a dollar to a pan. No quarry

or other vein was discovered in the vicinity. The 'mother lode' of California is in many respects the most remarkable metalliferous vein in the world. No other has been traced so far, has so many peculiar features, or has been worked with a profit in so many places. The great argentiferous lodes of Mexico and South America, the most productive of precious metal of all known in history, can be followed not more than six or eight miles, while this California vein is distinctly traceable for more than sixty. The general course of the vein is very nearly northwest and southeast, and dips eastward, and usually at an angle of 45° or 50° to the horizon. The main vein varies from a foot to thirty feet, but the spurs or branches make it almost one hundred feet wide. The most remarkable side veins are those of talcose slate, and can be traced for miles. They are from two to twenty feet wide, and are rich in gold. There is a belt of greenstone on the eastern side of the lode. In some places the walls are as smooth as glass. The strikes and dips of the Mexican mines have the same general tendency as those found in the 'characteristics of mines' in the latter part of this manual; and the country rock is largely composed of porphyry, greenstone, quartzite, and the metamorphic rocks. The vein stone is almost always quartz. The Alder Gulch placer mine is an instance of an exceedingly rich deposit, $30,000,000 having been taken out in three

years. The Potosi mine, in Bolivia, is a remarkable instance of the richness of a regular shafted mine, the production from 1545 to 1803 being $1,150,000,000, as given by Humboldt. Placer mines are from a few feet in depth to over a thousand, gold being found all the way down, generally increasing in quantity, so that if surface indications are discovered anywhere the earth should be examined to a proper depth. Some gold is so fine and dusty that it will float for hours in water, and if care is not taken in washing the indications might be lost. Vein rock is worked holding such fine gold that it cannot be detected with the unassisted eye, and gives a result of $35 to $60 per ton. Fissure veins are generally lined with slate or 'putty gouge.' The preceding introductory information and the knowledge to be gained from the following pages will be valuable to prospectors of the precious ores, and may be the means of saving many fruitless efforts by suggesting where and how to properly seek for indications of especially gold and silver.

MINERAL-BEARING ROCKS.

The Earth's crust or shell consists of two distinct kinds of rocks, the plutonic or igneous, and the sedimentary or stratified. The former are composed of granite, which is the foundation rock, and porphyry, basalt, &c., which are more recent. These, as their name indicates, were formed through the agency of fire. They are sometimes forced up in a melted state, greatly changed by excessive heat and pressure, through the later or sedimentary formations, and receive the name of volcanic or eruptive rocks, such as lava, trap, &c. The stratified or sedimentary rocks were formed by sediment gradually settling down in water, and eventually becoming stratified, and for this reason they are sometimes called aqueous rocks. The most common of the stratified rocks are gneiss, mica slate, clay slate, hornblende slate, talcose slate, quartz rock, sandstones, conglomerates, and limestones. There are about forty distinct layers or leaves to the Earth's crust, each formed at a different epoch, and under marked conditions. Between the igneous and regular sedimentary formations are what are termed the metamorphic rocks, which are mostly stratified slates that have been much

changed. It is in these stratifications that the valuable minerals and ores are mostly found. Some of these are sienite, porphyry, greenstone, trachyte, amygdaloid, &c. Granite is composed of quartz, feldspar, and mica, of different degrees of fineness or coarseness, and of every shade of color, but usually gray. Sienite is composed of quartz, feldspar, and hornblende, — the latter sometimes absent. This is often called granite. The Quincy granite of Massachusetts is sienite. Porphyry is a compact feldspathic rock, of purple, brown, green, and other colors, with crystals of feldspar disseminated through it. Greenstone is a compact rock composed mostly of hornblende and feldspar, and in color is from dark-green to brown or black. This and basalt, trachyte, and amygdaloid in all their varieties are called trap rocks. Basalt resembles greenstone, and is composed of augite and feldspar. It is often columnar in structure. Trachyte is a gray, rough feldspathic rock, with crystals of feldspar scattered through it, and sometimes containing hornblende and mica. The name amygdaloid is applied to any of the trap rocks filled with cavities, either empty or containing quartz, spar, epidote, or other minerals. Modern lavas vary in composition, structure, and color, and are compact or porous according to the different conditions under which the molten matter may cool.

GOLD AND SILVER INDICATIONS.

NEW ENGLAND.

MASSACHUSETTS.

New England has been looked upon generally as not only bearing a soil hardly fit for cultivation, but too poor to contain any thing but stone suitable for building purposes. The people accordingly, determined to make the most of the natural resources, use the granite for building, make the water useful generally for turning the wheels of mills, and in the winter utilize it in the form of ice, relying mainly for prosperity upon their manufacturing products. With superior inducements elsewhere, in easier lands to cultivate, and visions of wealth from mining awaiting moderate labors, it has been almost a constant warfare against unfavorable influences which has kept this section of the country from retrograding instead of advancing in prosperity. The idea that there was any mineral wealth has always seemed too preposterous for belief. It is true that iron ore was found in Saugus, Massachusetts, soon after the first settlement was made, and iron works were established and

maintained for several years, but the finding of ore was believed to be an exceptional case, although it has been discovered and worked in other portions of the State, and we have trusted to foreigners and Pennsylvania for the supply of our wants. Coal was discovered a generation or more ago in Bristol county, Massachusetts, and in Rhode Island, and a distinguished head of a college, whose opinion was asked, is said to have expressed the belief that in the final conflagration of the earth the coal would probably be the last thing to burn. Gold was discovered many years ago in Vermont, with indications that it would be found in Massachusetts; but about that time, or soon afterwards, placer or surface mining in California led to the belief that Green-Mountain gold was not worth searching for. So, too, a discovery of lead was made in Southampton, and several ineffectual attempts have been made to develop the mine. In these various discoveries there was either no faith in meeting with success in continued investigations, or it was supposed that the same minerals could be obtained at less cost elsewhere in exchange for products from easier labor.

The announcement of lead and silver at Newbury was received with no little incredulity, in view of former discoveries resulting in lack of success. Even after a point was given to newspaper correspondence that there was a great excitement in that vicinity, it was difficult to get

p much enthusiasm upon the subject. Owner
f land in the neighborhood tightened thei
rip a little more firmly when strangers came t
urchase; but so strong has been the caution
hat even now, on improved prospects, the lanc
upposed to contain mineral is held not near sc
igh as land for garden purposes is held ten
iles from Boston. Cool and cautious as have
een many of the residents, the indications are
uch that their incredulity gives way, and they
egin to believe that 'there are millions in it.'
Old miners who have had long experience in
California, Nevada, and New Mexico, and who
first believed that there was to be but a slight
ower, have come to the conclusion that there
ay be a flood, or in other words, find indica-
ions of richness that needs only labor to demon-
trate the fact.

It is not alone in Newbury that these indica-
ions are found. Beyond, and into and through
New Hampshire, and through Maine to Bangor,
pecimens of rock have been obtained which
promise as well as the mining at Newbury. In
a southern and western direction through Row-
ey, Georgetown, and other towns to Wakefield,
here are similar indications, and how much far-
her in that course the developments may be
made, remains to be seen. The fact is demon-
strated that underlying a large portion of the
surface of New England there is a great amount
of mineral wealth, and in that belief there will

be a very thorough investigation wherever the line of mineral wealth is supposed to run, not only by owners of land but by the curious and the seeker after hidden treasures. Whether their labors are rewarded with success or not will not affect the question. As in all past times, there is a strange fascination in digging gold and silver; and the continued depression of business, and idleness of multitudes of laboring men, will stimulate the hunting for mineral wealth. On that account, a good service may be done to the community in furnishing practical knowledge on the subject, so that those who own lands may judge for themselves whether they have value or not for mineral wealth, and may not be imposed upon by sharpers, while a great amount of labor will be saved which would be thrown away in useless endeavors to find mineral where there is none. It may perhaps appear singular that men of science should find indications and make predictions of mineral wealth in the western part of Massachusetts while they saw but little in the eastern part of the State to warrant such predictions. Silver was discovered in the lead mines of Southampton some fifty years since, and existed in the proportion of $12\frac{1}{2}$ ounces to the ton of the ore; but this, while greater than the average proportion in the English lead mines, was not deemed sufficient inducement for the working, probably as much on account of the indifferent methods and the high price of

labor as from other considerations. As above stated, there have been several renewals of the work, but we do not know that much profit has ever been derived from the mining. The opinion was expressed at that time by Professor (afterwards President) Hitchcock that it was not improbable that when several other ores in the State, such as arsenical iron, sulphuret of iron and zinc, should be accurately analyzed, they would be found, as in other countries, to contain a larger proportion of silver. Arsenical iron was found in mica slate in Worcester many years ago, and was explored to considerable depth. Lead ore was also found to some extent, but for some reason mining was abandoned, and the mine filled up. Sulphuret of iron, or iron pyrites, often mistaken for gold, is found almost everywhere, but is of no use except in large quantities. In several towns in the county of Worcester — Hubbardston, Southbridge, and North Brookfield — the quantity is abundant; and in Hubbardston a manufactory of copperas was established, but we do not find any account of its operations in past years. Zinc was discovered in the greatest abundance in the lead mines of Southampton, Hatfield, and Leverett, and in sufficient quantities to be worked to advantage.

Gold was discovered in Vermont about the time of finding silver in Massachusetts. The manner in which it was brought to notice was

not like that of the gold in California, yet like in some respects, in first being found by a workman in a stream of water, in which, however, he searched for it. This was in the town of Somerset, about twenty miles north of the line of Massachusetts, the stream being one of the head branches of the Deerfield River. An iron mine had been worked in that place, and a forge established, the ore yielding a large per cent of iron; and the workman learning that the gold at the South and in Mexico was found in talcose slate, and might be expected to be found in that formation about the head waters of the Deerfield River, set about the discovery. His search was rewarded in the first instance in the finding of a piece of gold of the value of more than a dollar, and subsequently of other pieces. Considerable quantities were taken out in the imperfect method of washing in those days. In other discoveries which were made a piece was taken out three or four miles south of the iron mine, which was sold for $68, and another piece weighing eight and a half ounces was taken in the town of Newfane, twelve or fifteen miles east of Somerset. As showing that gold was not confined to the talcose slate formation, the rock at Newfane contains but little of that formation.

The iron ore, as found in Somerset, was in beds in talcose slate, and much of it was brown oxide contained in a porous quartz. In this quartz

was found spherical pieces of gold, and specimens of the quartz and iron were undistinguishable from the gold ore in the mines of Virginia and North Carolina. There was more or less of iron sand mingled with the gold. Southern miners who visited the place were of the opinion that a large tract of land would be found to contain gold in the soil. The talcose slate formation which is a continuation of that in which the iron and gold is found in Vermont runs south across Massachusetts, and is found in Florida and Savoy in Berkshire, Rowe, Charlemont, Monroe, and Hawley in Franklin, and in Plainfield, Cummington, Worthington, and Middlefield in Hampshire counties. The conditions of the formation in Hawley are much the same as in Somerset. The talcose slate formation is found also in Berkshire county in the Taconet and Saddle mountains, with the porous quartz and oxide of iron. In the construction of the Hoosac tunnel there were hopes if no great expectation that some valuable minerals might be found in the course of the excavations. As these excavations were through mica slate, and talcose slate is found on both sides of the mountain, it may be thought that the talcose slate ought to have been found. We have the highest authority for the statement that the principal deposit of the rock is in the mica slate of the Hoosac mountain range, but it occupies a very elevated portion of that range. This is a sufficient

reason for failure to encounter the talcose slate, unless the portion near the western portal of the tunnel designated as demoralized rock by a distinguished opponent of the measure was an indication that something of the kind might be found in connection therewith. In this porous quartz on a closer examination gold possibly might have been found. This, however, is simply thrown out as a suggestion.

In following the line of this formation into Vermont, it is found associated with limestone and gneiss in the Green Mountain range. It is not known to extend south far beyond the line of Connecticut, while a narrow strip passing through Monson and into Somers, Conn., lies between mica slate and gneiss. In Cumberland and Smithfield, R. I., two strips of talcose slate are separated by a range of granite. In Smithfield there is a bed of talcose slate known as a whetstone slate. In this connection it may be said of the mingled slates at Smithfield, as the opinion of Prof. Hitchcock, that the whole series is the graywacke slate, which by the agency of heat has been partially converted into argillaceous slate, talcose slate, and hornblende slate, the heat not having been powerful enough completely to accomplish the transmutation. The chlorite slate, a species of the talcose, is believed in its associations to pass into the hornblende slate and gneiss. The steatite or soapstone, another species of the talcose, passes

through towns already indicated, and through Windsor in Berkshire, and several towns in Hampden county. At Zoar, near the Hoosac tunnel, mica slate, talcose slate, steatite and serpentine are found interstratified. In Middlefield steatite is found with talcose slate on one side and hornblende slate on the west; in Blandford a bed of it is found in mica slate, and in another place a vein of granite lies in contact with it. Steatite beds in Shutesbury, Wendell, and New Salem are surrounded by gneiss. The most considerable quarries of this stone in Massachusetts are at Groton, Andover, and Newburyport, while it is found in New Hampshire, Connecticut, and Rhode Island. Those at Groton and Andover were for a time worked quite extensively. The dip of the strata in these kinds of slate in the Hoosac mountain range is generally from 70° to 90° east, in the direction of north and south; in Smithfield, R. I., the direction is nearly southeast and northwest, and the dip from 10° to 15° northeast, and in many places nearly horizontal.

The gold in Vermont is found in situations similar to those in this and in other countries, mingled or embedded in quartz and hydrate of iron, and contained in talcose slate. Yet it must not be concluded that gold is never found in any other positions. The mingling of the various kinds of slates designated with granite and gneiss in proximity would lead to the indi-

cation that veins of quartz containing gold may be found in all these slates, and in granite and gneiss. These gold-bearing veins of quartz are found in other rocks in France, Peru, Mexico, and in this country. This opens a wide field for explorations in a section so largely made up of granite as is New England. There is no occasion to point out where granite can be found. It is clear enough too that all granite does not contain gold-bearing quartz, else we should already be rich from the product. Yet the stimulus from the fact that it may be found in such stone will be likely to lead to the breaking up of multitudes of rocks on the line of the supposed gold formations.

Lead ores in which silver has been found to more or less extent have been the subjects of discovery for fifty years at least. The Connecticut-River valley has been the most fruitful heretofore of the sections of the State in which lead has been found. Recent investigations show that lead is to be found in all sections of Massachusetts. In Southampton, to which reference has been made, a mine was long since worked to a considerable depth. The matrix containing the ore was a mixture of quartz and sulphate of barytes. A difficulty encountered was in the great accumulation of water, and, this overcome, the excavation was continued nine hundred feet, when, through an accident, and the low price of lead, the operations were

abandoned. The vein is said to have promised well, and was of considerable richness. Operations since then were resumed, and then suspended, the last owner having died within a year or two; yet it is not unlikely that in the renewed attention given to the subject the mine will be again worked. The lead obtained was the sulphuret, besides which there was found the carbonate, sulphate, molybdate, muriate, and phosphate of lead, together with the sulphuret of zinc, pyritous copper, and fluor spar. Another vein was found in the same town, running for several rods on the surface of the ground. In Northampton, near the same time, a vein of galena was found, the matrix of which was radiated quartz with walls of mica slate. In Williamsburg a vein was discovered extending into the town of Northampton, the matrix of which was quartz. Another vein in the same town extended into Whately. In a third vein in the town the quartz was in loose masses on the surface. In Goshen a mine was found with mica slate and quartz. In Whately there were three veins found, one of which contained oxide of manganese with the galena, and another traversed granite and mica slate in a quartz matrix. In Hatfield a vein of sulphate of barytes contained galena. In Leverett veins were found, one in granite, with a matrix of barytes, and another with a matrix of quartz. Lead was found also in many other towns in that section of the State,

—in Uxbridge, Russell, West Stockbridge, Norwich, and Alford, — of which Professor Hitchcock said: "Of one thing, however, I think we may be assured, from the facts that have been stated, viz., that the central parts of Hampshire county contain extensive deposits of lead, which may be of great value to posterity, if not to the present generation. Probably many more veins will hereafter be discovered, since little examination has been made with a view to bringing them to light." This remark of Prof. Hitchcock was made more than forty years ago, but the fact that the veins have not been worked to advantage do not weaken the statement as to the value of the mines. At that time the price of lead was very low, and the depression was referred to the glutting of the market with lead from Missouri. With higher price and improved facilities there can be little doubt that many of these neglected mines will be reopened, and new energy imparted to operating them. There was little said about the silver found with the lead, but as those were the days when silver coin in circulation was plenty, the happy days predicted by Col. Benton, when through the interstices of the purses of even the poorest citizens gold and silver would shine, possibly might account for the omission. The predictions of further discoveries in that section of the State, as well as in the east, have been verified, for we have recently heard of discoveries in various towns.

statement is made that specimens of lead containing a large proportion of silver have been recently taken on a farm in Monson. It would be difficult to remember all the localities in the eastern portion of the State in which lead has been recently found. It is presumed everyone has become familiar with all the operations in and about Newbury, and that proper allowances have been made on account of the natural exaggerations which usually accompany statements made under the excitement of new discoveries.

Iron ore in the carbonate form was found in Newbury forty or fifty years ago of a peculiar quality for the manufacture of the best of steel. We do not know that it has been availed of to any great extent. Magnetic iron has been found and worked in Warwick, Franklin county; but the most productive iron mines are in the town of West Stockbridge, where they have proved to be of great value. Iron ores have also been found in many other places, in few of which have they been worked to much advantage.

As illustrations of the folly of attempting to mine without any scientific knowledge on the subject, it is related that in 1815 an act of incorporation was obtained of the Easton Lead and Silver Mining Company, with a capital of $80,000. The operations of the company were in red granite, and after an excavation of nearly one hundred feet, and the killing of two men, with no other result, the operations were aban-

doned. In many places in Massachusetts, as in other States, a great amount of labor and expense have been wasted, when the simplest scientific knowledge would have dispelled the delusion. The superstition in the use of the devining-rod has not yet passed away, for we hear of its being used in various places. There are or were not long since those who believed in the agency of Satan in the finding or secreting of mines or hidden treasures, but if such belief has passed away, there are doubtless follies not less absurd which are yet fully entertained.

In the failure to find indications of gold, silver, or lead except in the western portion of the State, as a result of the geological survey forty years ago, there is a strong argument for a new and more thorough one. In fact, that survey was made to a great extent in the interests and for the promotion of agriculture, while commerce, as the leading pursuit of importance, had begun to decline, and manufactures had not attained the importance which they reached under the railroad system. In this respect Massachusetts stands at a great disadvantage with New Hampshire, where a survey was made subsequent to that in this State, and a more extensive and much more valuable one has been made within a few years, of the result of which one volume alone, while there have been several accompanying reports, has as yet been published.

Some of the principal features of the geology

of Massachusetts, as given by Prof. C. H. Hitchcock of Dartmouth College, are as follows: —

Certain rocks at Newbury are classed as eozoic, as showing evidence of the existence in the same strata of numerous plants and low forms of animal life. To the ancient system are referred the gneissic rocks of the Hoosac mountain range; the sienite on both sides of the sandstones of the Connecticut valley; the mica schists with the granite about Amherst and Leverett; the sienite and porphyry of Eastern Massachusetts; possibly the gneiss and granite of Plymouth and Bristol counties, and the gneiss and hornblende schist of Middlesex county. In Amherst and Leverett there is much mica schist, but more granite, associated with patches of sienite, resembling the rock of the same name about Boston. Among the paleozoic rocks are classed the paradoxides slates enclosed by the sienites and porphyries in the eastern part of the State, the rocks west of the Hoosac mountains, and the metamorphic strata between the mountain range and the Middlesex county eozoic series. In Norfolk and Bristol there are true coal measures, extending into Rhode Island. The rocks of the paradoxides group consist of slates, grits, and conglomerates. There are similar rocks upon Parker river, in Essex county. A basin of clay slates in Worcester county connected with a fine mica schist is probably paleozoic. The associated rocks extend down the valley of the Merrimac

to its mouth. It contains an extensive bed of plumbago, near Worcester, thought to be a metamorphic coal bed of the carboniferous age. A large area of gneissic rocks in the centre of the State runs northerly into the White hills of New Hampshire, between Worcester and the Connecticut valley.

The quartz rock west of the Hoosac mountain extends into Vermont and appears to change into the red sand rock. The formation dips beneath the limestone, reappears and disappears, and passes into Connecticut. The Stockbridge limestone occupies the whole of the valley of Berkshire county, and passes under the mass of schist constituting Graylock. It is believed to be not less than 2000 feet thick. The talcoid schist, several thousand feet thick, constitutes the masses of Graylock and the Taconic range of mountains. The talcose schist extending from Vermont into Rowe, and thence to Blandford, tapering there to a point, including mica schist between it and the Hoosac tunnel, has been followed into Canada. A band of calciferous mica schist occupies an area east of the talcose band and west of the mesozoic sandstones and the granite of Goshen and Westhampton. Their beds of dark siliceous limestone are interstratified with the schists.

The coal measures of Bristol and Plymouth ounties, including Rhode Island, occupy 750 quare miles, and are 6500 feet deep. The low-

est part is a coarse conglomerate, succeeded by rough slates, covered by a second conglomerate. The indication places it among the lowest coals, or those that have been largely productive in the anthracite region of Pennsylvania.

In the Connecticut-River valley is a basin of red and gray sandstones and shales, correlated with the new red sandstone of Europe, several thousand feet thick. In these rocks are the noted fossil foot marks. The western part of Martha's Vineyard is occupied by tertiary strata, probably of the miocene age. The clays are white, red, yellow, and green, and sands white, yellow, and green. Green sand is also found in Duxbury, Marshfield, and Nantucket. The Merrimac schists run along the valleys of the Merrimac, Concord, and French rivers from Sudbury to Webster. Sienite underlies large sections of Essex, Middlesex, Norfolk, and Plymouth counties. A stratum of granite extends across the State from Duxbury to Fall River, and calcareous or ferruginous gneiss is the basis of the central section of the State. The Alpine region also from Monroe to Sandisfield rests upon the same formation.

NEW HAMPSHIRE.

In mining New Hampshire had a reputatio
long since far in anticipation of anything whic
has been obtained; yet there is a probabili

that in the present thorough researches that those anticipations may be realized. Near Nashua, in the river of that name, are the Mine Islands, so named from their supposed richness in minerals. It was believed that lead had been found and wrought by the Indians from an early date. A grant of the islands was made to Hezekiah Usher nearly two hundred years ago, and a miner was sent over from England to explore the mines. Yet the lead was not found in much abundance. This Usher, who was an uncle to the governor of New Hampshire, appears to have had visions of mineral wealth in store for himself, and in the grant of lands there was "farmed out to him and his heirs all the mines, minerals, and ore within the limits of New Hampshire for the term of one thousand years," Mason, the proprietary, "reserving to himself one fourth of the royal ores (gold and silver) and one-seventeenth of all the baser metals."

The early surveys in New Hampshire, as well as in Massachusetts and other States, were made especially in view of the promotion of agriculture, with little or no expectation of finding valuable minerals. As long ago as in 1823 an agricultural survey of the State was recommended by Gov. Woodbury, having in view a provision in the constitution of the State, "the promotion of agriculture, the arts, science, commerce, trades, manufactures, and the natural history of the country." Recommendations were subsequently

made of surveys for the advancement of agriculture and the arts. With reference to the slates of the State, the former geological report says "hornblende, talcose, and chlorite slates often occur in situations analogous to mica slate, and frequently alternate with the latter rock. The talcose slate is spoken of as a valuable rock for use, particularly the soapstone variety, and exists abundantly in the State.

In Canaan, in the western part of the State, adjoining Hanover, minute particles of gold were found long since, but in too small a quantity it was believed to be of any commercial value. The matrixes in which it was found are represented as the striated brown pyrites and the carious quartz. It was found also in Grafton, contained in the brown pyrites, like a deposit of the kind in the gold mines of the Ural mountains. It was believed too minute to be worked profitably, and Dr. Jackson expressed the doubt on an examination of the particles whether even the Siberian mines would prove of any value to the citizens of New England, where labor is worth so much more than in that country. He further expressed the opinion that the almost universal failures in the southern gold mine speculations demonstrated to our people that gold is one of the least productive metals. Notwithstanding all this ore was wrought in the Ural mountains on the slightest fraction of yield. The brown pyrites yielding the gold is found

in the talcose slate rocks of Claremont and of numerous other places. The vein of brown pyrites in Canaan was operated on a very economical scale by a joint stock company of fifty shares, at two dollars each, and when this immense capital was expended, it was believed that a further expenditure was not warrantable. A minute quantity of gold was found in the ore. Most of the pyrites had undergone spontaneous decomposition by the influence of air and water. The veins of these ores were six to ten inches wide, mixed with quartz, and included in gneiss rocks. They run north 5° west, south 5° east; dip, east 80°. The gneiss strata have a course north 35° east and south 35° west. The mine was opened thirty feet in length and twenty in depth. Associated with the pyrites were masses of carbonate of iron in crystalline folia of a deep brown-red color, and a little sulphuret of molybdena was observed. A continuation of the vein was traced to Grafton, where it is sufficiently rich in copper to be worked. Minute particles of gold were also found here.

A recent geological survey of the State, under the direction of Prof. C. H. Hitchcock, of Dartmouth College, shows a very extensive gold field in New Hampshire, known as the Ammoonusuc Gold Field, included in the territory occupied by the auriferous slates and schists along the Connecticut River, lying mostly in New Hampshire, partly in Vermont, and supposed to extend

beyond the sources of the Connecticut river into Maine and Canada, with the southern limit near Bellows Falls. Another report in relation to the alluvial gold of Indian Stream refers to it as in that part of the province of Quebec lying between the St. Lawrence, Maine, New Hampshire, and Vermont, in which the existence of gold in the alluvium has been known for many years. It is established that the area over which it extends comprises more than 10,000 square miles. The first discovery of free gold in the Ammoonusuc district was made in Plainfield in 1854. Shortly afterwards gold was washed out of alluvium in Lebanon and Hanover. The first gold discovered in Lyman was in 1864, by Prof. Henry Wurtz, from a vein of the New Hampshire Silver Lead Company. A sample assayed showed silver at the rate of 56.95 ounces, and gold at the rate of 1.006 ounces to the ton of 2000 pounds. A report published by Prof. Wurtz in the American Journal of Mining contained the remark on the Ammoonusuc Gold Field, the name of which he suggested, that the "history of this gold field presents probably for the first time the peculiarities of a first discovery in the solid rock, and not as usual by the tracing up of gulch gold to its home in the lodes." In 1865 a discovery of gold on an estate in Lisbon led to the organization of the Lisbon Gold-Mining Company. In the early prospecting, excavations were made in a swampy piece

of land on a brook, where the greatest amount of free gold showed itself within twenty feet of the surface. The gangue of the vein is quartz, one-twentieth part being composed of magnetic iron pyrites or pyrrotite, with a sprinkling of yellow copper pyrites. The assays showed $60 to the ton. Other openings were made, which indicated a vein of over four feet in thickness, bounded by a hard quartzite resembling gneiss. This company subsequently abandoned their own mine, and bought an interest in the Dodge mine, which was discovered in 1866. This discovery was made on a stone projecting from a wall, the face of the stone showing a large sprinkling of gold, the finest specimen it is said ever found in New Hampshire. In the search for a vein, the Dodge Gold-Mining Company was organized, commencing operations in 1868. In the course of three years about $16,000 in gold was taken out, considerable delay taking place in operating the mills. Its situation is upon an irregular band of clay slate, commencing in Bath and extending in a tortuous line into the north part of Littleton. The note-books of the surveyors contained notices of this kind of veins, often where no one suspected their existence. The principal vein on one of the openings of the Dodge mine is mainly a whitish quartz, often glassy, characterized by masses of slate, crystals of pyrites, ankerite or bitter spar, and galena scattered through it. The quartz

displays spangles of clear gold, adjoining slaty fragments. Assays of clear quartz make a yield of $18.11, and of the mixed constituents $18.90, per ton. In the returns made from this gold district, as determined in the government assay office, one of them gave $900 of gold and $4.50 of silver, or one per cent of silver. This is stated to be purer than the Nova Scotia gold, which contains from two to eight per cent, while the California gold averages one and two-tenths; Australia, four-tenths to one per cent; and the Chaudiere gold of Canada, or that nearest Lisbon, from ten to fifteen per cent of silver. One of the Dodge shafts has yielded from $10 to $14 per ton, and in one instance as high as $19.

Several other companies were formed in and about Lyman, some of which have done but little in developing mines. The Grafton Gold Mining Company has a mine in a talcose schist, the rock being dolomitic and somewhat slaty. The veins incline southeastwardly 55° at the surface, and about 45° at a depth of 25 feet. The vein is of limpid quartz, with many crystals of quartz, dolomite or ankerite, iron pyrites, and galena, with some free gold, the gold most abundant in the upper vein. The assays have shown an increase from $7 of gold per ton to the rock, at first, to $62.17 of gold and $1.33 of silver at a depth of 76 feet. From the composition of the rock it is believed that when pulverized, after the extraction of the gold, the materia

may be used as a good fertilizer. Companies are operating also in Bath, adjoining Lyman, and from a mine east of the Dodge a piece of gold taken from 500 pounds of material was valued at $28. On another farm in Lyman the specimens of gold have shown to better advantage than from any other location, yielding freely on the surface.

In relation to the alluvial gold along Indian and Perry streams, it is said that it is not unlike that at Lyman, yet more closely resembling that mined a short distance over the boundary line, where Mr. Pope, member of Parliament from the province of Quebec, has been profitably extracting gold by sluices for several years. It is believed that the gold can be profitably obtained both from the soil and the rock near the extreme northern boundary of New Hampshire. Of the deposits at Ditton, Canada, but three and a half miles from the boundary line, it is said that the average was $10 a day per hand by the common process of washing, and a nugget was found of the value of $134. These deposits have been compared with the deposits of Siberia. The gravel containing gold rests generally upon metamorphic schists, and in the Ural and Altai mountains the auriferous gravels are almost always found reposing on schistose rocks.

In answer to the question whether gold mining in New Hampshire will pay, Prof. Hitchcock

gives figures comparing the cost and yield of the mines with those of California, and comes to the conclusion "that while the yield is less and the cost of milling greater than in the average of California quartz, the New Hampshire rock may be classed within the limit of what are considered good mines on the Pacific slope, and further encouragement is derived from the probability that the cost of milling and mining may be reduced over one hundred per cent when the business has passed beyond the limits of infancy."

The supposed discovery of a silver mine was once made in Weare. It proved to be only iron pyrites. Another discovery of silver, in Dunbarton, turned out to be an ore of arsenic. This was found in a stratum of mica slate resting on granite. It proved to be heavy and rich in arsenic. Of the silver found in the lead mines of New Hampshire it is said "nearly all the lead ores of New Hampshire contain a sufficiency of silver to give a profit in its extraction from the reduced lead. The richness of the veins generally increased in proportion to the diminution of their magnitude, some of the smallest veins containing ten times as much silver as the wide ones." In regard to these lead mines, it is said in contrast that "none of the lead ores of Missouri yield any silver, nor do those of Wisconsin and Iowa, thus negativing the common supposition that all galena contains silver. It appear

to be confined exclusively to the primary and metamorphic rocks."

At Haverhill sulphuret of lead and sulphuret of zinc were found many years since. Lead was also found in Bath and Lyman, several specimens of which contained a small proportion of silver. It was then believed that it would not be worth extracting unless very large quantities of the ore could be found north of Haverhill. Those conditions have now been fulfilled, and several lead mines have been worked in the vicinity of the gold mines already referred to. Some of them show 'heavy quartz outcrops,' and the assays indicate a value in silver to the ton of 2240 pounds of lead of from $154 to $192.50. A silver lead mine in Madison, Carroll county, shows in an assay nearly eight pounds of silver to the ton of 2000 pounds of lead. The selling price of the ore has been $113 per ton, $55 for silver and $58 for the lead. The mine has been known for fifty years, but not much worked till within a short time. Recently additional rich discoveries have been made if newspaper reports are to be considered reliable.

A lead mine at West Ossipee shows about an equal proportion of silver to lead as at Madison. At Warren, not far from Haverhill, and at Rumney, southeasterly from Warren, lead mines have been worked. At Orford, on the Connecticut River, a short distance below Haverhill, accounts have recently been published of rich discoveries,

and great excitement thereon. Tamworth, Madison, Ossipee, and Eaton are near together in Carroll county, in all of which places lead has been found. In Eaton lead was found fifty years ago; and for a time the mine was worked quite extensively. The lead ore contained 84 per cent of lead, and zinc ore 63 per cent. One pound of silver was contained in 1000 pounds of lead. It was believed in those days to be one of the largest and richest mines of its kind in New England. The dip of the vein was found to be west-northwest 51°, running in the direction of north $27\frac{1}{2}^{0}$ east, and south $27\frac{1}{2}^{0}$ west.

In Shelburne a lead mine was explored many years since, and the veins were found to widen on their extension. These veins were generally in an east and west direction, with a dip to the north 60°. Although worked to some extent it was abandoned, while it was believed it might be made profitable under the charge of a good mining engineer with sufficient capital, mines of a less promising character being worked successfully in Europe. In Warren lead ore was worked which contained two per cent of silver. Copper and zinc it was supposed might be obtained to advantage in Warren. In Sandwich, also in Carroll county, a lead mine has produced three pounds of silver to the ton of lead ore. Carroll county appears to be prolific in lead ores, and doubtless a large part of its territory contains the ore in great abundance.

There are a number of copper mines worked to good advantage west of the gold fields, in copper belts in the towns of Monroe, Lyman, Bath, and Littleton; also a mine at Dalton. A zinc mine in Warren has been profitably worked. Copperas has been manufactured in Unity where are deposits of copper and iron pyrites. The argillaceous slates are found in that vicinity, and from Claremont to Meriden micaceous slate. In Orford, where recent explorations have brought to light rich silver ore, an immense bed of talcose slate was found to exist long ago. It was said when the first survey of the State was made, that it answered perfectly for soapstone, and was quarried to some extent. The bed was included in mica slate, with a dip of the strata of the rock 10^0 north 35^0 west. The walls of the mica slate cropped out at the summit of the hill and at its base, but the walls of the talcose slate had not been fully explored. The thickness of the bed was estimated at 100 feet, and probably even of greater dimensions.

There are valuable iron ores in New Hampshire, and a vein of tin, also mines of plumbago, which have been worked. Most of the valuable discoveries which have hitherto been made, and to which attention has particularly been given, are in the western and central portions of the State, but if recent investigations are to be credited, the eastern section, from the connection with the silver mines at Newbury to the

unquestioned gold indications in Maine, will probably prove to be not less rich in mineral wealth.

MAINE.

The first geographical survey of the State of Maine, more than a generation ago, disclosed many valuable mineral deposits. Among those believed to be the most profitable to be worked were the limestones and the slates. These have been quarried to great advantage, in adding to the wealth of the State. The slates were said to be of better quality than those of Wales, and the limestone is very extensively sent out of the State. One of the most important slates with which this treatise has to deal is that of the talcose slate, very abundant in Maine. At Dexter many years ago an analysis of ore taken from a small vein in the slate rocks indicated that the ore was rich in silver, but at that time the veins were not found to be sufficiently large to warrant mining to any extent. It is but fair to say that in this, as in many other cases, geologists were very cautious in not stimulating mining for the precious metals through want of general knowledge on this subject by the public, and the requirements of large capital for the operations of mining. In the early surveys reliance was placed more on other ores as possessing the most value; hence we find that Dr. Jackson,

in speaking of the trap dikes, says: "Even the little information which the Cornish miners have given respecting the intrusion of the dikes serves there as the clew to the discovery of valuable veins of copper, tin, and iron ores. Such will be the result in Maine, and to as much greater extent, as the facts are well observed and recorded for future reference."

Talcose slate is found in the limestone quarries at Thomaston, on Lime Islands in Penobscot Bay; at Hope, in connection with limestone; on the walls of quarries at East Thomaston, Rockland, and at Camden. This slate is also found at Scarborough, Sewell's Island, and in other places. In a report by Prof. C. H. Hitchcock, in 1861, he states that a belt of rocks of an indistinct talcose or micaceous character was found at Belfast, on the north side of the gneiss of Lincolnville and Northport. The talcose schist, he says, consists normally of successive layers of talc and quartz. Often the talc is replaced by talcite or some mineral resembling talc, and what is often called talcose schist is only an altered variety of clay slate, while the true talcose schist is a rare variety among the talcose schists in all parts of the world. There are five or six deposits of this schist in Maine. One of them is in Cumberland county, near Portland; and it appears to extend from Saco to Orr's Island. It has been observed in two places in the east and southeast parts of Saco, and Cape Island is very

largely composed of it. The city of Portland is underlaid with it, interstratified with some mica schists. Forty years ago the senior Prof. Hitchcock suggested the similarity of the rocks about Portland to those elsewhere which contain gold; and yet the people of Portland have been sleeping unconsciously all this time over these deposits of gold. The later geologist suggests that, under the circumstances, it may be well to examine the foundations of Portland for it. Northeast of Portland this rock appears upon most of the islands in Casco Bay, also in Harpswell. Near the light-houses on Cape Elizabeth, the rock exhibits a remarkable tendency to split in the direction of the layers, like wood. The rocks at Belfast are largely composed of talcose schist, forming a belt several miles in width and of unknown extent northeasterly and southwesterly. This is supposed to be more like the Portland than the Thomaston schists. Other deposits have been found on the wild lands, quite extensively on the waters of the St. John river above the mouth of the Little Black River, and on the Aroostook road between Patten and the north part of township six, range five, extending some twenty-five miles. A narrow belt of the rock was also found in the north part of Hodgdon. It is also said further that there is a large amount of talcose schist in the immense clay-slate formation in the central part of the State. There is talcose schist also in Charleston

and Dixmont. Near Patten the dip is first northwesterly, and near the line of township six the dip is 75° southeast. On the St. John River the rock dips 61° northwest. The rock on this river extends as far as the mouth of Great Black River. Small beds of clay slate are occasionally associated with the schists. Large boulders of talcose rocks, some of them ten feet in diameter, are common the whole distance above the Seven Islands. Near the mouth of the Alleguash River the rock is talcose in appearance, and, below, the rock is genuine talcose schist, but of limited extent. It should be said, as the result of the second year's examination by Prof. Hitchcock, that he styled some of the schists in the interior micaceous schists, which he had spoken of as talcose, with occasional talcose variations; and that which Dr. Jackson pronounced talcose in Thomaston, Rockland, and vicinity he styles as taconic argillo-micaceous, the talcoid being obscure as compared with similar rocks designated as talcose in Massachusetts and Vermont.

Gold is found on an extensive tract in the northwestern part of the State. In its native condition it has been found only in the alluvium. The first discovery was in Madrid, by a California miner. It has been found on the Sandy river in various localities, between its source and New Sharon; and between Sandy river and the Canada line it has been found in many places. It is believed from these facts that there is gold in

the rocks of Somerset and Franklin counties. Against the supposition that it has its origin in Canada rocks, it is said that it is too widely distributed in the soil and too abundant to be of foreign origin. Prof. Hitchcock remarks that gold is by no means confined to talcose schists, but may be found in veins in most of the azoic rocks. The rocks of these counties are mostly azoic. Another gold region is believed to exist farther north, on the upper part of the St. John River. The talcose schists there are of the same variety as those in which gold is commonly found, and the same as that which has yielded gold in the southern States, in Vermont, and on the Chaudiere River in Canada. Specimens of gold have been found also on that river. In regard to extracting gold from iron pyrites, it is said the pyritous gold mines are often more valuable than the quartz leads, since a new process has been discovered by which the pure gold may be easily extracted. Of these pyrites there are large beds in Maine, on Jewell's island in Casco bay, in Brooksville, Troy, Anson, Farmington, New Limerick, and other places.

A subsequent examination of the valley of Sandy River showed that the rocks contain the peculiar veins of quartz in which metallic gold is disseminated. The opinion in relation to the auriferous character of the country upon the upper St. John River was confirmed on another inspection, and the limits were enlarged. It is

believed to extend nearly to the Moosehead Lake on the Penobscot, and perhaps along the dividing ridge between Maine and Canada, even to the New Hampshire corner. Where the Canada road crosses the belt in Sandy Bay the veins look very promising, and the banks of the stream are full of the black sand which so generally accompanies gold. The veins are very abundant there, and it is only a short distance to where gold is washed out of the Chaudiere River. The purest auriferous belt brought to light crosses the St. Croix River above Calais. An examination of veins of mica schist, full of quartz veins and beds, near the railroad bridge in Baileyville, showed several pieces of bright flaky gold. The best locality appeared to be on the west side of the river. This gold field was believed to be very similar to that in Nova Scotia. Both are somewhat different from those in California and along the Apallachian region of the United States and Canada. The great peculiarity of the Nova Scotia gold consists in its dissemination through the quartz in such fine particles that it is rarely visible, yet it would yield richly. Auriferous veins have been opened in Cutler, where the yield of a ton of rock was $100. The lowest amount that pays is $20 per ton. Discoveries of gold have also been made in Columbia. Specimens have been extracted from masses of quartz in the vicinity of Calais. The rock from which the quartz is obtained is

sienite, the quartz partaking of a carnelian character. Pyrites of an auriferous appearance are found in Machias.

Lead ores were found in several sections of the State many years ago, but not in large veins. The Lubec mines were first worked to the most advantage. The veins widened as the explorations descended, but on account of depressions in business the operations were given up for a time. Some specimens of ore contained eighty-three per cent of lead. The working of the mine was subsequently resumed, in the opening of a new vein. Prof. Shepherd described the discoveries of sulphuret of lead as truly wonderful, far surpassing the most sanguine expectations, and probably equalling, if they did not surpass, an extraordinary mine not long before opened near Port Jervis, New York. A mine at Denbo point, a few miles distant, promised a rich return of silver lead. A similar vein to those at Lubec runs through the town of Corinna a distance of several miles. In Parsonsfield, at Kezar falls, a vein of lead and zinc ore has been found. The vein runs ten degrees east, and shows itself in Denmark. In Dexter there is a mine of lead ore which was discovered a great while ago in digging a well in slate rock charged with veins of quartz. It was found in the quartz, associated with iron pyrites, ochreous oxide of iron, sulphuret of zinc, and sulphuret of copper and iron. The vein widened as it extended in

depth, the ore being from one to three inches in width. The dip was 40° or 50° to the southwest, the vein running north 70° west, south 70° east. Associated with the ore there was an abundance of green talc, soft and flaky when obtained, but hardening on exposure to the air. An analysis showed it to be a rich argentiferous galena, only larger veins being needed to make the working profitable. The amount of silver was at the rate of one pound to each 500 pounds of ore. Veins of lead have also been found in Rumford, Blue Hill, and other places.

In Raymond there is an iron mine of some note, and in Rumford and Dixwell a paint mine and considerable quantities of bog iron. There are said to be inexhaustible beds of iron ore of the best quality upon the Aroostook river, and large deposits are found in the State. Tin and copper ores have also been found. The conclusion at which Prof. Hitchcock arrived at the end of his survey of the State was, that when her mineral resources shall have become fully known, every one would be astonished at their immense extent and value.

VERMONT.

This State was the first of the New England States in which gold was found, and the earliest discovery was in Newfane, to which allusion has already been made, a nugget of the weight of

8½ ounces and of the value of $125, being found on West river. There does not appear to have been much excitement occasioned by the discovery, while the impression was given that it had been brought there from abroad. It was believed that a family of suspected counterfeiters who lived there must have dropped it, yet it was supposed that they were too poor ever to have owned it. But such was the doubt about gold being found indigenous there, that in the first geological report of the State, this piece of gold was stated to have been lost by the counterfeiters on their being routed from the place. Subsequent investigation showed that there was gold there in the talcose schist. Yet it was not till 1851 that the people got over the idea that the finding of gold in Somerset was a trick of the owners of the land for speculative purposes, when gold was found in the talcose slate in Bridgewater, in a matrix of quartz. The fortunate finder did not disclose the fact until he had secured a title to the land. Gold was found in three or four distinct veins of quartz within a space of eight rods, when a gold fever was the result, and a company was formed which went into operation in 1854 with all the appliances for gold mining. The mining did not appear to be very successful, and the property reverted to Mr. Kennedy, the finder of the gold. The mining property was purchased by a California miner in 1859, who carried on the work by improved processes.

There was no question of the finding of gold in Bridgewater in considerable quantities, but the needless expenditures and the loose and extravagant manner in which the works of the company were managed was believed to be a sufficient reason to account for the suspension of the labor. The auriferous quartz veins vary in thickness from a few inches to several feet, and in them we find specimens of the sulphurets of copper, lead, and zinc. In the most western gangue or matrix numerous cavities occur in which a yellow oxide was found, and on analysis a large per cent of gold was found in it. The oxide closely resembled that taken from the side pockets of the celebrated gold mines of North Carolina. Good specimens of gold were found in the auriferous quartz, which are to be seen in the State capitol at Montpelier.

On account of these discoveries prospecting was pursued in other places, resulting in the finding of considerable gold in Plymouth. The purity of the Plymouth gold exceeded that of California. An assay in 1855 showed it to be $23\frac{1}{4}$ carats fine, and 136 pennyweights before melting showed 133 after melting, of the value of $132.40. Considerable prospecting was the result of these operations, and in a claim in Plymouth of less than two rods square, a miner took out in 1858, $400 worth of gold. Wm. Hankerson, the miner, pushed his investigations in the most approved manner. Prospecting was

also done in Stowe, Worcester, and Granville, but those who were inexperienced in mining did not meet with much success. Most of the gold was washed from the gravel in or near the bed of streams of water, and when the survey of the State was made, it was believed to be highly probable that Plymouth and other portions of the State would furnish dry diggings in old river beds through which no water now runs, but which were worn down at remote periods of time by streams that now wend their way through other valleys or through other portions of the same valley in which living streams are now running.

The gold of Vermont, with the exception of that found in the auriferous quartz of Bridgewater, has been found generally in the unmodified drift of river valleys. Sometimes it occurs at the surface of recently-deposited gravel, and continues the entire distance to the bed-rock; but usually the gold, and especially the coarser kinds, is found on or near the bed-rock at the bottom of the valley. By bed-rock is meant the solid rock upon which the gravel, boulders, and other loose material are situated. In many cases, upon reaching the bed-rock, rich deposits of gold are found immediately under gravel, in which scarcely a trace of it exists. Gold deposits in Vermont prove to be confined to certain rocks. It is believed the auriferous belt extends the entire length of the State and has a width equal

to that of the talcose slate formation. Talcose slate is a stratified rock of a greenish color, but in some specimens where gold is found the slate is of a dark color, the surface often tarnished with the oxide of iron, and upon splitting open the weathered specimens, they have a shining black or dark lead color. In the dark variety of the talcose slate, small angular cavities are common, in which it is supposed there once existed the cubic crystals of iron pyrites, which, upon exposure, decomposed and formed the rusty, tarnished surface of the slate. Concretionary masses and veins of quartz of a porous, granular variety are also abundant in the slate. The quartz, like the slate, has a rusty appearance, and not unfrequently is filled with an oxide of iron, and, in the more compact portions, crystals of iron pyrites are met with, some in a perfect state of preservation, and others partially decomposed.

The indications of these deposits were much like those of North Carolina, finding gold in the ochre from a cavity in quartz; yet gold is sometimes found in small flattened masses between lamina of slate. In some instances the gold is found traversing the slate in feathery veins, crossing the lamina at various angles, and in other cases it is found in quartz, entirely free from any sulphurets or foreign matter. In the larger nuggets there are found almost invariably small sub-crystalline massess of quartz, disseminated through or adhering to it. Miners usu-

ally regard the occurrence of quartz veins of talcose slate as a sure indication of the existence of gold in the gravel overlying and in the vicinity of it. The occurrence of the gold is more abundant in the vicinity of the black talcose slate, sometimes called plumbaginous slate, and usually found best developed near the serpentine and soapstone beds that occur at intervals nearly the entire length of the State. So certain is the rule, that a California miner asserted that he did not think he ever worked a dollar's worth of gold five miles east or west of the line of serpentine and soapstone beds, or five dollars' worth a mile east or west of them. In these beds there is usually a great abundance of rhomb or bitter spar, which upon decomposition leaves a deposit of the oxide of iron, in which there is found gold in very fine grains.

It is believed to be evident from this that gold is not confined to ore rock, but is found associated with quartz, soapstone and talcose slate, and the pyrites and spar associated with them. Yet gold is not scattered indiscriminately among all the rocks of the State, but is confined to the talcose slate formation. This schist extends over a large portion of the State, and it is evident that the occurrence of gold is equally extensive. The forest belt of the talcose slate is a narrow one, and extends up the Connecticut Valley from Rockingham to Essex county. The second and most extensive devel

opement is found on the eastern side of the Green Mountains, and extends the entire length of the State. In the northern part, the mountains are mostly composed of talcose schist, and it is believed that the gold fever will at some time run with considerable violence. In western Vermont the hill and mountain tops are composed of talcose or talcoid schist, that rests upon limestone or marble, and in the valleys gold is not unfrequently found. In other cases, on the eastern side of the Green Mountains, gold is found in the gravel reposing upon a bed of gneiss, but it is usually in very fine particles, or scale gold, doubtless transported by water from its bed in the talcose schist. Even the cautious geologists who made the survey of the State express the opinion that gold is scattered over extensive districts in the State, and will be found in other places than those surveyed, while it is not at all improbable that other nuggets may be found equalling in size and value the one found in Newfane.

Gold washing was carried on for some years quite extensively and successfully, and gold was found in the eastern part of Springfield. Dry diggings were worked in the valleys of Buffalo, Reading Pond, Gold Brooks, and other places. An old miner, in a recently-published letter, says: — "I have prospected for gold in thirty towns in Vermont, and find gold in each of these towns, but in few places in paying quantity, ex-

cept in the town of Plymouth, where I am now working a claim at a profit. A good paying mine cannot be worked at a profit unless by a practical miner who understands how to collect and save the gold."

There are beds of silurian rocks in Vermont, some of which are like the Galena limestone, yet there are none such as are shown in the west. Small veins of galena have been found in some of the metamorphic rocks of the State. A lead mine exists in Thetford, in a vein traversing strata of talcose slate. In Norwich, adjoining Thetford, there is also a lead mine. The discoloration of the soil for a considerable distance it is believed would show a prospect which in Dubuque, Iowa, would make a claim eagerly sought for. In Morristown a vein has been worked that occurs in the talcose slate. In the matrix were found sulphurets of lead, zinc, and iron. It was sixteen to twenty inches in thickness. Lead has also been found in Bridgewater and in Plymouth, near the gold washings, on Dorset Mountain, near its eastern base, and in Chittendon.

Some traces of silver have been shown in connection with the lead mines of Thetford, also from the ore obtained at Morristown. An assay of this ore gave a yield of one-fifth of one per cent, equal to four pounds of silver to the ton of metal. This the chemist said would be well worth working, provided the lead was abundant.

One pound of silver to the ton would more than repay the cost of extraction, since lead yielding but four ounces to the ton had proved profitable in Great Britain.

RHODE ISLAND.

In Rhode Island there have been no indications of gold, while silver and lead, iron, copper, and coal exist, in some cases in considerable quantities. A variety of later micaceous slate is extensively quarried at Woonsocket for scythe-stones. A rock known as fire-stone, belonging to this formation, in Woonsocket, extends into Uxbridge, Mass., where it includes a vein of lead. Silver in the lead proved to be in the percentage of seven pounds to the ton of ore. The talcose rock is of limited extent. Chlorite slate is found in Cumberland, Smithfield, and Johnston, associated with talcose rocks, constituting the walls of their beds. In Cumberland there is a thick bed of manganese, peculiar in its composition. The coal plants of Rhode Island are said to have a remarkable resemblance to those of the anthracite regions of Pennsylvania, and some of them closely resemble those of the bituminous coal mines of Nova Scotia, New Brunswick, England, and France. The coal beds in Portsmouth are believed to be very extensive. An estimate of the contents of three beds which are known makes the amount to be nearly

40,000,000 tons. Beds of iron ore exist in Cumberland, known as the Iron Mine Hill, which are found nowhere else in New England, and from these beds boulders have been displaced which are scattered profusely around Providence and upon the island of Rhode Island to the distance of eight or ten miles. It is estimated that there are in this hill more than 6,000,000 cubic feet of the ore above natural drainage. The ore is remarkable on account of its geological situation, and its mineralogical and chemical composition. No less than fifty different holes, evidently ancient, have been found in one hill in Cumberland, and excavations of considerable extent have been made, supposed to have been caused by the finding of yellow copper pyrites, doubtless mistaken for gold, and it is estimated that more than half a million of dollars must have been expended in fruitless researches for precious metals. Cumberland is represented as a very complicated geological district, and a coal mine is opened on the line of Massachusetts.

CONNECTICUT.

It is not recollected that gold has ever been found in Connecticut, and in an early survey of the State, it is stated that no deposit of iron pyrites has been found of sufficient extent to justify any manufactures from them, nor has

any of this ore been detected including appreciable traces of gold. Some indications of the auriferous variety were noticed in the chloritic slate formation of Orange. Decomposing iron pyrites in cubical crystals, with dull, brown surfaces, was frequently observed in the neighborhood of Savin Rock; and an ochre, rarely embracing portions of decomposed ore, was disseminated through a quartz vein several feet in width in the central part of Lambert mine. Although on examination by washing no traces of gold were discovered, it was believed the favorable indications warranted the prosecution of inquiries, if not for the economical, at least for the scientific, value of the discovery.

Lead has been found in numerous places in the State, some of the ores unusually rich in silver. One of the best known is at Middletown, on the Connecticut River. It occurs in a thin bed or seam of quartz included in mica slate, having a thickness of from ten to twenty inches. The dip of the slate is 35^0 to 45^0 west. The ore is associated with blende and iron pyrites, rarely with yellow copper pyrites. It was formerly worked to a considerable extent. In Brookfield a mine was discovered which was supposed would prove profitable. Many good mines, it is said, have been opened in other countries under less favorable auspices than were presented by this mine. The main branch of ore was soon exhausted, but there were slen-

der threads or leadings which might be expected to show good results. All of the indications were encouraging for a valuable mining district. A mine was opened in Monroe, where a variety of other ores were disseminated through an immense bed of quartz. The lead was not found in great quantities, but an analysis showed from two to three per cent of silver. Other lead mines have been discovered in Wilton, Newton, Berlin, Canton, Bethlehem, Plymouth, Chatham, Trumbull, Bethany, East Haven, and Southington. At Sandy Hook, in the town of Newtown, search was made for coal, revealing lead; in Kensington Parish, Berlin, the diggings are very old; the veins containing the galena, blende, &c., are at the junction of a ridge of trap with indurated shale. In Chatham the lead is found in a cobalt mine; at Trumbull, near the topaz vein it is associated with copper pyrites; in trap at East Haven, and in granite in Canton. At Wilton the mine is called a silver mine. Excavations are said to have been made here as long ago as during the revolutionary war. The rock penetrated was a quartzy granite bed, situated in mica slate. There were thrown out among the materials, minute portions of galena, copper pyrites, iron pyrites, and mispeckel. At Sandy Hook the mine was also called silver: galena and iron pyrites were found attached to the walls of the excavations. A lead mine was opened in Ancram and a large

quartz vein of talco-chloritic slate. The ore is associated with copper, zinc, and iron.

Copper mines have been worked to a considerable extent in Connecticut, in some cases in a chloritic formation; in Southington in an apparently sub-talcose or sub-chlorite rock; also in Bristol in a vein of coarse, reddish, sub-talcose granite. Iron ore is found in various portions of the State. Talcose slate in the western portion of the State is ordinarily of a light gray color, more or less deeply green and chloritic, adjoining quartz veins. This association of ferruginous quartz veins with a gray talcose slate, green and chloritic adjoining the veins, is said to present no slight analogy to the more usual rock in the gold regions of the Southern States.

In relation to the finding of certain minerals in primary formations, Dr. Percival says: "The occurrence of particular minerals is not the result of accidental deposition, but of original crystalline or chemical action, and is therefore controlled by specific laws. If, then, within the limits of any given formation an important mineral has been profitably explored, and if indications of the same occur more or less frequently throughout the same formation, search for that mineral may be reasonably made within its limits, and the indications observed may be taken as guides in the examination."

BRITISH PROVINCES.

CANADA.

In the statements already made in relation to Canada, considerable interest must be shown to learn more of the auriferous deposits which mark a portion of the gold field bordering on Vermont, New Hampshire, and Maine. Mr. Michel, who made a survey some years since, was formerly a manager of gold mines in South America, and devoted three years to the region on the southeast side of the St. Lawrence. At the time of the examination, American companies had acquired possession of a great part of the auriferous lands along the borders of the rivers Chaudiere, Famine, De Loup, and other tributaries. He speaks of the existence of alluvial gold over a great extent of territory in Eastern Canada, and he presumes there may exist other localities as rich in gold as any yet discovered. In referring to the deposits, he says, the gold is generally so smooth, so much rounded, and worn by friction, that it appears to have come from some distance. As long ago as 1852, a geological commission had estimated, as the extension of the auriferous alluviums in Lower Canada, that they covered

more than 10,000 square miles. The gravels through which the gold is generally distributed, are generally covered by a layer of vegetable earth, and often by a bed of clay. They repose in part upon metamorphic lower silurian rocks, consisting of schists, generally talcose, micaceous or chloritic, associated with the diorites and serpentines. But to the southwest these lower silurian strata are unconformably overlaid by others of upper silurian age, which are also covered by gold-bearing alluviums. These upper rocks consist of argillaceous schists, with sandstones and limestones all more or less altered. A comparison of the gold deposits makes them conform more to those of Siberia than to those of any other country.

At a place called the Devil's Rapids, on the Chaudiere, gold was found most abundantly in the cavities, fissures, and cracks of the clay slates which often form the bed of the river and its tributaries. In the bands of slate in which it is often found, the gold is tarnished by a black earthy coating of oxide of manganese. The Gilbert River was an important source of yield for many years. The district drained by the Famine and Du Loup, as far as the frontiers of Maine, has been the subject of numerous explorations. The valley of the St. Francis was also a source of attraction for gold seekers. The Ascott gold mines at one time had a large yield of gold, and the Golconda Mining Company, an

American corporation with a large capital, once assumed that there was an existence on their tract at Ascott of $14,000,000, $3,000,000 of which were supposed to be in the alluviums.

It is stated that the old rock formations upon which the gold-bearing alluvions of Canada East repose contain numerous veins or bands of quartz, which run ordinarily in the direction of the stratification, northeast and southwest. These veins are often concealed from view over large areas by a covering, variable in thickness, of vegetable soil, or other superficial deposits. The quartz is generally white, although sometimes colored by oxide of iron. Some of these veins seem almost free from foreign minerals, while others contain metallic sulphurets, such as cubic pyrites, arsenical pyrites, blende, argentiferous galena, and sometimes native gold. In the seignory of Vaudreuil quartz veins attracted great attention, also in the seignories of Aubin-Delisle and Aubert Gallion, and in the townships of Jersey, Marlow, Limiere, and Matgarmette. Quartz in one vein assayed $136 of gold to the ton, and another $77.56 of gold and $2.55 of silver to the ton. In another case silver gave the largest yield. Mr. Michel comes to the conclusion that, with cases of exceptional richness, there are considerable areas whose methodic working may be made remunerative, and that the search for gold-bearing veins should not be confined to a few localities.

Alfred R. C. Selwyn, in charge of the survey, who made an examination of the gold fields of Quebec and Nova Scotia in 1870, reported that he found gold explorations confined mainly to washings on the streams. Mr. Selwyn indicates some of the causes prejudicial to the permanent and healthy progress of mining industry — in rash expenditures of capital in the purchase of mining rights; the erection of costly machinery for mining and treating the ores before their value has been determined; the attempts to enhance the value of stock by dividends out of capital; devoting whole net proceeds to dividends; the small areas or claims; disregard of natural features of the ground in locating machinery; and in the want of appliances for saving pyrites and fine gold. In a comparison of the working of mines in Nova Scotia with those in Australia, it is found that the yield and the cost are in favor of Nova Scotia, but the unskilful, wasteful, and improvident manner in which business is conducted creates distrust and apathy, and destroys the confidence of investors.

NEW BRUNSWICK.

It might be expected that as in the States and Provinces adjacent to New Brunswick gold is found it would prove to be there also. This is true, but to what extent we are unable now to

assert definitely. Gold has been discovered in Albert county within a few miles of the borders of Maine. At St. Stephens, in the vicinity of Bathurst, on the Serpentine and Wapkahegan branches of the Tobique River, gold also exists. The indications are much the same as in Nova Scotia, where the yield has been some $20 to the ton of quartz. On the land of Mr. Bolton, in St. Stephens, gold has been obtained. The locality of the gold is in a plumbaginous slate, very black and greasy. Near it was a large boss of quartz, with sub-veins of quartz running through it, and there were also veins containing pyrites. This is but a few miles from Baileyville, on the St. Croix river, mentioned in connection with gold in Maine. The same schistose rock in which gold is found continues on both sides of the St. Croix river, in New Brunswick as well as in Maine.

NOVA SCOTIA.

It is said of this Province, that there is no district on this continent, not excepting the Grass Valley mines of California, where the reduction of auriferous quartz has been more successful than in Nova Scotia. The districts where gold is found are of two different geological ages. The district on the Atlantic coast, extending the whole length of the peninsula, is fifty miles in width at its western extremity,

gradually narrowing almost to a point east at Cape Canso. This is the lower silurian rock region, and the other region is the devonian and upper silurian, extending from Digby county along the south side of the Annapolis valley to the vicinity of Windsor, in one section ; another commences at Cape Chiegnecto, forms the Cobequid hills, and proceeds eastward to the strait of Canso, throwing off spurs to the gulf of St. Lawrence, and on both sides of the Stewiacke River. A considerable portion of the island of Cape Breton belongs to the same formation. These districts comprise a large proportion of the surface of Nova Scotia, the area of the lower district being estimated at 7000 square miles, and the other tracts about 10,000 miles, making an aggregate of 18,600. The great part of this area there is reason to believe is rich in metalliferous deposits.

The several ridges of highlands in the devonian district have been but little explored for gold, the rocks being rarely exposed, covered with a deep soil and a heavy growth of timber. The gold is found in the alluvium brought down by the streams from the hills. In Wagamatkook quartz has been mined to a small extent, but most of the gold is obtained from the beds of streams, and the quantity thus obtained indicates the presence of numerous auriferous quartz veins. Gold has been discovered in the sands of nearly all the streams of Victoria and Inver-

ness which rise in these metamorphic hills. It has also been found at Cape Porcupine, near the head waters of other rivers, and at Five Islands, and elsewhere, and it may be sought for with expectations of success in any portion of the district.

Much more is known of the lower silurian coast band, where are found bands of quartzite nearly parallel with each other, alternating with various slates extending in a general easterly and westerly direction. These bands are intersected by masses of granite, in some instances extending quite across the whole formation, but more frequently in detached masses, protruding through and surrounded by the stratified rocks named. To appearance, it is said, in the aggregate they form the largest portion of the width, superficially, of this metamorphic district skirting the Atlantic.

In relation to the favorable comparison between working the quartz veins in Nova Scotia as compared with California, two important elements concur in this result—the cheapness of commodities under light taxation, and the great facilities of access from the sea, and by good roads.

CHARACTERISTICS OF CALIFORNIA GOLD MINES.

App. — Strike, nearly north and south; dip, 63° east. The quartz carries a small percentage of sulphurets, and is enclosed in hard greenstone on the hanging-wall, and talcose slate on the foot-wall.

Heslep.—Strike, nearly north and south; dip, 60° east. The vein is quartz and slate, highly charged with auriferous pyrites, with some antimonial sulphides. The vein has a hard greenstone on the foot-wall, and slate on the hanging-wall.

Von Tromp. — The vein was discovered in a hard limestone, but after a thirty-feet shaft was sunk, the vein became hard, bluish quartz, impregnated in the limestone, with a separating gouge or seam. A depth of seventy feet struck through the limestone into a slate ledge, where the vein increased to twice its first width, and became enclosed in well-defined walls.

St. Lawrence. — Strike, nearly north and south; dip, 45° east. The foot-wall is smooth and polished, but the hanging-wall is not so regular. A gouge of black talcose slate accompanies the hanging-wall, facilitating the extraction of the quartz. The country rock is greenstone;

and the quartz is blue and laminated, and rarely shows free gold. The sulphurets, about one per cent, yield from $300 to $500 per ton.

Cedarberg.—Strike, north and south; dip, 70° east. The formations are greenstone and slate. This mine has been noted for its enormous product of singularly-rich specimens of foliated gold.

Princeton.—Strike, northwest and southeast; dip, 55° northeast. The vein is composed of white, friable quartz, and is divided into parallel layers or plates by thin slatey films, which are generally charged with fine-grained pyrites and free gold. The body of the quartz bears white-vein pyrites, crystallized and spread in irregular patches, and a small portion of galena, together with free gold in irregular ragged masses, in plates and scales, and sometimes crystals. The gold appears to be most abundant in the neighborhood of the galena, and is found not only with the iron pyrites striking its sheets through its substance, but entirely isolated from it and enveloped in the pure white quartz.

Pine Tree.—Strike, northwest and southeast; dip, northeast. The particles of gold in the quartz of this mine are so fine as usually to be invisible to the unassisted eye. The veins are characterized by the presence of oxides and carbonates, especially blue and green carbonate of copper.

Josephene.—Strike, northwest and southeast; dip, northeast. Greenstone is found in some

places, and slate in others, the latter being richer in ore. There is no gouge in the greenstone. Where the vein is small the quartz is mixed with slate.

Mariposa.—Strike, nearly east and west; dip, 51° south. The vein forks, one prong running westward, the other north of west. The rock is a white ribbon quartz. The walls are black talcose slate; but little gouge; and the quartz is so hard that it has to be blasted. East of the fork the gold is in fine particles and evenly distributed, but west of the fork the gold is collected in rich pockets, separated by masses of poor quartz. The pockets contain almost always arseniurets of iron accompanied by pyrites. The presence of these minerals is considered a certain sign that a good deposit of gold is not far distant. One of these pockets paid $30,000, and another $15,000.

New Britain.—Strike, east and west; dip, south. The vein stone is a soft white and yellow quartz, which breaks up like slaked lime when exposed to the air. The walls are hard black slate. This vein contained a number of very rich pockets, one which yielded $52,000, costing $5000 for labor.

Black.—Strike, east and west; dip, south. The hanging-wall is mountain limestone, and the foot-wall yellow slate. The vein stone contains marble.

Louisiana.—Strike, northeast and southwest;

dip, northeast. The quartz contains sulphurets of iron, zinc, and lead. Along the foot-wall there is a streak of soft yellow sandstone six or eight inches thick.

Flannigan. — Strike, north and south; dip, west. Cuts across the slates. There are smooth slate walls on both sides, and a putty gouge three inches thick.

Coward. — Strike, east and west; dip, north 45°. The walls are of smooth black slate, and there is a black putty gouge. Most of the gold is found near one wall or the other, and sometimes on both; but in places where a horse is found in the vein, the gold is all confined to one side. The quartz contains little pyrites.

Marble Spring.—Strike, northwest and southeast; dip, east. The lode contains pockets in which the gold is very coarse, and is distributed in beautiful threads through a compact bluish quartz.

Mary Harrison.—Malvina vein.—Black talcosè slate on both sides of the vein. The gold-bearing portion of the rock is a hard ribbon quartz near the walls, while in the middle there is soft, shelly, white, and barren quartz.

Woodhouse. — Strike, north and south; dip, west 45°. The walls on both sides are granite, and there is a white clay gouge, which is generally found on the foot-wall. The pay quartz is white near the surface, and at a greater depth is bluish, and rich in sulphurets. The barren

quartz is white, glassy, and coarse-grained. The vein is crossed by several trap dikes which are nearly vertical, dipping slightly to the south.

Oneida.—Strike, nearly north and south; dip, 65° east. The foot-wall is slate, and the hanging-wall greenstone. The quartz is white and blue, with some ribbon rock, which contains more free gold than is found in other parts of the vein. There is a black putty gouge on the foot-wall. The walls are in places as smooth as glass.

Hayward.—Strike, north and south; dip, 75° east. The hanging-wall is hard serpentine; the foot-wall is slate, polished smooth. There is a continuous black putty gouge. The gold is nearly all free. This is one of the richest mines in the State.

Keystone.—This mine includes two claims; the Keystone strikes north 48° west, and dips 52° east; the Geneva dips 64° east. The foot-wall of the Geneva is slate, and the hanging-wall is a hard greenstone. The wall of the Keystone vein on the west is generally hard, well-defined, and regular: on the east it is softer, and frequently incorporated with the quartz. The ground in many places is loose, and the vein seems to have been subjected to great pressure, crushing the quartz to powder. There are many horses of hornblendic slate in the Keystone vein. The quartz is mixed with green and black talcose slate: the green contains good pay. The croppings were rich.

Hinckley.—Much of the gold is black or purplish, offering a singular contrast to the white quartz in which it is found. Some of the gold is found in little sheets or leaves, rolled up or tied up in a very singular and unaccountable manner.

Woodside.—Strike, northeast and southwest; dip, southeast. The walls are slate. On one occasion, a mass of rock was found so bound together with seams of gold running through it that a cold chisel had to be used to cut it. The lode is rich in sulphurets, and has peculiar sheets of sulphurets about an eighth of an inch thick, with transverse crystals running from side to side.

Union. — Strike, northeast; dip, 60° southeast. The rock is a blue ribbon quartz, richest near the sides. One and a half per cent of the vein matter is sulphuret of iron, lead, antimony, and zinc, which, concentrated, assay from $200 to $6000 per ton.

Independence. — Strike, east and west; dip, south. Granite hanging-wall, and 'blue trap' for a foot-wall. The quartz is rich in sulphurets.

CHARACTERISTICS OF NEVADA SILVER MINES.

Comstock.—Strike, north and south; dip, 16° east. The enclosing rock on the east throughout its entire length as far as known is 'propylite,' a species of porphyry, varying much in its appearance at different points, as the crystallization is coarser or finer, and decomposition more or less advanced. The country rocks on the west vary considerably. On the slopes of Mt. Davidson and Mt. Butler it is sienite; north of this propylite occurs on both sides; while in southern Gold Hill various metamorphic rocks occur on the western side. The west wall of the lode is separated from the country rock by a well-defined clay selvage. Considering the vein as a whole, it is safe to say that at least two-thirds of it are filled with immense horses, or masses of country rock, chiefly detached from the hanging-wall, between which are found the belts of metalliferous quartz. Portions of the lode are filled with a brecciated mass of porphyry quartz and clay. In Gold Hill the ore occurs in sheets. The ores of the Comstock consist chiefly of vitreous silver ore, stephanite, native silver, and argentiferous galena, imbedded in a quartz gangue. Beside these ruby silver,

horn silver, polybasite occur in small quantities; also native gold, iron and copper pyrites, and zinc blende. These usually occur in an amorphous condition.

EASTERN NEVADA.

Reese River.—The mountain range in which the silver was found is composed, geologically, of primitive rocks, of which granite or gneiss and slate are the principal, while quartzite, limestone, serpentine, porphyry, and others as occasional varieties. In all are found veins of quartz-bearing gold, silver, copper, lead, antimony, and other metals. The general character of the ore throughout the district is the same in the same relative positions. At the surface, and to the depth of fifty to seventy feet, where water is found, the vein matter is loose and friable, has a dirty or earth-stained appearance, and the silver is found in the form of a chloride ore, presenting a dark or straw-colored aspect. When the water is reached, the vein matter shows the white, clear quartz, and the ore then, usually an antimonial sulphuret, is quite black, and, contrasted with the white quartz, presents a beautiful appearance.

North Star.—In its first stages of development it exposed a chloride of silver ore, but at a greater depth the ore was a sulphuret. The vein is encased in granite.

Great Eastern.—The gangue is a clear, white

quartz, and the ore which constitutes a large percentage of the vein is an antimonial sulphuret, or, as locally termed, a ruby silver, from its dark-red or ruby color.

Mount Tenabo.—The vein is embedded in the bosom of Mt. Tenabo, a peak 11,500 feet above the level of the sea, and upwards of 5000 feet above the surrounding valleys. The scarred and rugged mountain looks eternal. Some 3000 feet above its base a vein of silver-bearing quartz cuts its face obliquely, burying itself in the mountains at one end, and penetrating into the valley at the other, after stretching out in palpable view to the length of 18,650 feet. Its width is 400 feet. The vein rock is quartzite.

Newark District.—The geological formation is slate and limestone, the latter carrying great abundance of fossil shells. Deep chasms are cut in the mountain side which exhibit the character of the rocks. The Chihuahua cañon exposes veins of silver-bearing quartz. The ore exposed is an antimonial sulphuret.

Twin-River District.—The geological formation is granite and slate; the districts north of it are limestone.

Pahranagat District.—The chief physical features of the district are a lofty peak, 11,000 feet high, with other hills and peaks constituting a range of mountains. The mountain is a mass of white porphyritic rock, the flanks consisting of a blackish limestone (abounding in

fragments of crinoids and corals) overhanging slates, and capped with a heavy body of quartzite. On Silver Hill and Sanderson Mountain the outcroppings of the lodes are in limestone. On the western range, crystalline eruptive rocks are abundant. The trend of the mountains is north and south, and the strike of the veins is generally northeast and southwest, with a slight dip to the southeast, or stand nearly vertical. The principal mineral deposits are found in a belt about five miles long and two wide, stretching across the foot-hills and spurs of the mountain. This belt contains several distinct systems of lodes, all bearing the features of true fissure veins, having smooth and, in places, striated walls with clay linings. They are of medium size, many of them cropping boldly, and traceable for a good distance. The country rock is principally a metamorphic limestone, the stratification greatly disturbed. The ores on the surface are associated with copper and argentiferous galena, and show by assay a percentage of silver varying from $50 to $2500 per ton. The vein stone is quartz and calc spar, carrying iron, zinc, and manganese.

CHARACTERISTICS OF OTHER MINES.

ARIZONA.

The mountain ranges of this country are a prolongation of those which, southward in Chihuahua, Sonora, and Durango, have yielded large quantities of the precious metals, and which, northward in Nevada, are attracting the attention of the world with their wealth. The general direction of the mountains and quartz veins is northwest and southeast. The silver ores found in Southern Arizona are argentiferous galena, native silver, auriferous sulphurets of silver, black sulphurets of silver, sulphate of silver, sulphate of iron combined. The gangue is usually quartz or feldspar. The copper ores are usually sulphurets, principally grey. Nearly all the silver and copper lodes show traces of gold, and placers have been found at many points.

Mowry.—Strike, east and west; dip, south. The walls are limestone and granite-like porphyry. The vein renders sulphurets and carbonates of lead in manganese, often pure, containing iron, frequently in large chambers.

Maricopa Lode.—Copper.—The formation of the district is primitive, chiefly granite and sien-

ite, with metamorphic and sedimentary rocks, and injected dikes of trap and quartz. The vein stone is quartz, with seams of argentiferous copper ore, at the surface a few inches wide, but at six feet depth they are nearly solid, filling the whole vein. The outcrop consists of carbonates and silicates, while the main body of the vein consists in general of grey sulphurets of copper and other ores, which appear upon the surface.

Colorado-River District. — The lodes are in the mountain ranges. The country rock is granite and slate. The silver veins are in pink and white quartz. The ores are chiefly argentiferous galena.

Moss Lode. — The rock is dark-colored and iron-stained, the country rock is porphyry, the hanging-wall smooth and hard. Some remarkable specimens of gold ore have been taken from this lode. In blasting, in some instances, pieces have been torn out yellow with gold, and the face of the lode has shown streaks of the precious metal. The gold is of a bright color, and usually found in layers as thin as paper.

MONTANA.

The mountain ranges trend northwest and southeast, and all contain mines of gold and silver. The mountains are much abraded by rains, frosts, and glacial action, leaving them very smooth. Almost at the summits of the highest ranges beds of gravel containing placer gold

have been formed from the disintegration of the neighboring peaks. Thus, placer mines are found on the mountain tops. Veins of gold, silver, copper, and lead have been found in very great numbers in nearly all the explored mountainous portions of the territory, and placer gold is as widely distributed. Many of the gulches have proved vastly rich, and some of them very extensive. So far as discovered, these veins come to the surface on the foot hills, and on the sides of the valleys and cañons, and some of them cut the mountains to their very tops. A large portion of the lodes are true veins, cutting through granite, sienite, porphyry, gneiss, mica slate, trap, hornblende slate, talcose slate, argillaceous slate, sandstone, and limestone. These lodes vary in thickness from a mere line to sixty feet. The gangue or vein rock, called quartz by the miner, is very variable in character. In the gold-bearing lodes it is usually whitish quartz, more or less ferruginous, often nearly all iron. In some veins it resembles a stratified quartzite; in a few it is sienitic, pyrites, hornblende, calc spar, arsenic, antimony, and copper. Tellurium and micaceous iron are found in these veins. In the silver lodes the iron, so abundant in the gold veins, is often replaced by the oxide of manganese. The mineral is sometimes so abundant as to constitute a very large portion of the gangue. The gangue in many of the copper veins is made up of quartz, spars, oxides of iron.

Dakota. — Strike, northwest and southeast; dip, northeast,—which is the general strike and dip of the veins in this locality. This is a large, irregular vein, distinctly traced on the surface for over a mile in length. It carries the oxidized ores to a great depth, containing free gold easy of extraction. The country rock enclosing the veins is limestone, of a late geological epoch, and rests unconformably upon sienites.

Argenta.—The quartz veins are in limestone, and contain lead and iron. The hill on the north side of the creek and opposite the town is a perfect network of veins, which are very irregular, and many of them when followed down are broken, and the continuation lost. The whole hill appears to be full of bunches or pockets of ore irregularly deposited.

Helena. — This is one of the richest mines in Montana. The country rock is limestone and slate; farther up in the mountains granite prevails. A large number of gold-bearing quartz veins are found in it, from which the gulches below receive their gold.

Park District. — Strike, east-southeast and west-northwest, dipping northward. The mineral range is in granite. On the northeast this district is bounded by a range of limestone. The greater number of veins is found in the granite near its junction with the limestone. In some of the veins sulphurets are found near the surface; but generally for a considerable distance they are oxidized.

Alder Gulch.—The ancient mountains in this vicinity have been ground down into softly-undulating hills, covered with soil. A careful examination of the gulch will convince anyone that the gold in it came from near the head, at its junction with Bald Mountain. The gold at that point is coarse and rough, with portions of quartz adhering to it; farther down the stream it becomes finer and brighter, showing unmistakable evidence of having been worn by the action of water. Near the mouth it is excessively fine, and cannot be collected in a satisfactory manner except by the use of quicksilver. The gravel is very coarse and heavy high up the gulch, containing many boulders of a large size; farther down it becomes worn away to small particles, and at the mouth only sand and very fine gravel are found. The country rock at or near the head is gneiss, and the same rock holds for a considerable distance; below it is replaced by micaceous slate. Near the head the rocks rise on each side in a very precipitous manner. Frost and atmospheric action loosen the quartz containing the gold, and throw it down, when the attrition caused by the current of water pulverizes and washes away the gangue, leaving the gold behind. It is the opinion of those best qualified to judge that within three years from the commencement of mining operations on this gulch about $30,000,000 were taken from it.

IDAHO.

Salmon River.—The situation of these mines is remarkable. The deposits of gold are in a marsh on the top of a mountain, in the centre of a basin called Meadow Creek. This singular depression is nearly circular, about twelve miles in diameter, and surrounded by high mountains, except an opening to the south. The mountains on which the mines are situated is granite, nearly circular at its base, rising from 500 to 1000 feet, and about four miles across. From its top a number of flat, marshy ravines ramify in every direction. They are from 20 to 150 yards wide, and filled with peat and muck to depths of two to twenty feet. Under this was a stratum of rough, unwashed gravel, which had evidently never been much removed. This contained the gold, and was very rich, the best parts yielding a dollar to a panful of gravel. Very little black sand was visible. A careful search failed to result in the discovery of any quartz or other vein at the head of the richest ravines.

Boise Basin.—The country rock is granite, and the gravel containing the gold has but little quartz, sand, or boulders in it. Generally the quartz veins in the basin are soft; when detached and washed down a short distance in the stream, the quartz is finely pulverized and the gold liberated. A large portion of the soil is stained red by oxide of iron, and contains small amounts

of gold. On the sides and tops of the hills are masses of clay and gravel that yield handsomely. On Granite Creek are a number of veins with quartz so soft that two-thirds of the vein stuff can be washed in a common rocker without any previous crushing.

Poorman. — The strike of the vein is nearly north and south; the dip was at first west, but changed to the east at a depth of 150 feet. The character of the ore changed with the dip, as is usually the case. Chloride of silver, or horn-silver, is found in pure masses, with crystals of remarkable size and beauty. It is said sheets of this ore were found more than a foot square, and the sixteenth of an inch in thickness, some weighing many pounds. Black sulphurets of silver, or silver glance, is common in the mine; also polybasite.

MEXICO.

In most of the districts porphyry is found with micaceous schists, and the conjunctions of these two rocks with quartz veins is considered an indication of silver. The name of the Sierra Madre is usually applied to the main range of mountains of this country, or the western border of the plateau which stretches north through the territories of the United States, forming what may be called the great orographical feature of the continent. In northwestern Mexico this crumpled border of the great plateau com-

prises an extensive mountainous region, by no means forming a continuous single chain, but rather several central ranges, with associated groups of parallel ridges, all having the same general course, which is nearly north-northwest and south-southeast. This conformation is the same as that of the mountains of Nevada. Some of the best mining districts are situated on or near the summits of the mountains. The sedimentary rocks of Sonora are made up of heavy beds of quartzites and conglomerates. All of these are disturbed and elevated, and rest on greenstones, feldspathic porphyries, or granite. Wherever metamorphosed, the triassic rocks are auriferous, and contain veins of silver ores. In Durango and Sinaloa, gold, native silver, and sulphuret of silver occur, associated with galena, yellow blende, and iron pyrites. In Sonora the principal ores are argentiferous grey copper, with galena, black blende, copper pyrites, arsenical pyrites, carbonate of lead, ruby silver, arsenical silver, and gold. The most abundant vein stones are quartz, either chalcedonic, crystalline, or massive; brown spar; heavy spar; oxide of iron. The arsenical pyrites, which are auriferous in the Sierra Nevada, become argentiferous in the Sierra Madre. The veins vary in their direction from a little east to a little west of north. The richest ores near San Dimas run northeast and southwest.

METHODS OF ASSAYING GOLD AND SILVER.

The following methods of assaying, analyzing, or examining gold and silver ores are presented as the simplest and most convenient for the use of the ordinary prospector of the above ores.

GOLD.

Washing.— This operation can be performed with a shallow pan of any size, but one from six to eight inches in diameter, and about two inches deep, is a very convenient size. The sand or soil to be examined should be put into this pan, and held under gently-running water, stirring quietly the contents with a stick or the hand. If a brook or river is not near, water can be poured into the pan and the contents stirred in the same manner. If washing in a running stream, the soil or light sand will flow over the side of the pan and be carried off, eventually leaving the pebbles and heavier sand to be removed with the hand. When water is merely poured into the pan, the contents should be stirred till the water is muddy, which should be then carefully poured out, refilled, and the operation continued till no more sediment can

be displaced. When the contents of the pan have been considerably reduced, what remains can be washed in the side of the pan. As particles of gold are heavier than the residue of pebbles and sand, they will gradually sink into the corner, and the sand can be worked over the lip of the pan with care. A person to whom the process of panning is familiar can wash out almost every particle of foreign matter. If there is any gold in the pan, the 'color' will be easily detected under the shallow water by gently turning the pan so as to produce a slight movement in what remains. A small magnifying-glass or lens should be used to aid the eye in examining the contents.

Gold Ore.—This ore is quite difficult to examine satisfactorily; for sulphurets or oxides of iron are in appearance much like particles of gold. If a piece of ore be moistened, the examination will be facilitated, the gold under this condition remaining uniform in color. If the observer notices any sharp angles or flat surfaces to the particles under inspection, like those presented by a cube, he may doubt their being gold. But if they are gold, the sharp point of a knife will easily scratch them.

If the particles are too small to be properly examined with the eye, then the rock must be pounded into powder as fine as flour, and washed as before directed. Mineral rocks should be pulverized in an iron mortar, from which very

little of the dust can escape. Gold dust is not so bright as fragments of sulphurets, which flash in scintillations of different colors. Particles of gold have no particular shape, but are usually flattened or rounded, while the larger pieces are often rough or ragged.

Iron Pyrites and Gold.— Iron pyrites are often found in connection with gold, and these must be destroyed to liberate the precious metal. If gold is suspected to be present, the specimen should be exposed for about two days to a fair degree of heat, and allow the air to communicate freely with the rock or specimen while roasting. Great care should be taken that the heat be not too strong, for if the proto-sulphuret, which is likely to form soon after the exposure of the ore to heat, should be once melted, it will take considerable time to oxidize the mass. As minerals, and even sulphurets, if in large crystals, are liable to fly into pieces when brought suddenly into contact with fire, it is advisable to dry the specimen near the fire for twenty-four hours. By the roasting process the rock becomes friable and porous, and can consequently be easier pounded into dust.

Amalgamation.— Mercury.— This consists in reducing auriferous rock to a fine powder, by the process already stated, and subjecting it to a continuous agitation with mercury, with water enough to give a pasty consistency to the mass, the object being to expose as fully as possible

the fine particles of gold to the attractive power of the mercury, with which they form an amalgam, and are easily separable by subsidence from the lighter pulp of earthy matter of which the ore consists. The amalgam thus obtained, on being subjected to moderate heat in an iron retort, gives up its mercury in vapor, leaving the gold in the shape of a 'button' in the bottom of the iron pan or dipper. As there may be sulphur in the dust, the result will be more satisfactory if the rock or dust be subjected to roasting.

SILVER.

Assay of Silver Ores.—Native silver is seldom found in a sufficiently pure state to afford a chemically pure silver; on this account it should be smelted with a little metallic lead, as this will absorb the impurities which may be inclosed in the mineral silver.

Native silver is usually found alloyed with gold, which may be separated by the dry analysis. Silver ores are found in a great variety of forms, this metal combining with almost any kind of material.

Silver ores are assayed very much in the same manner as gold ores, differing only in the degree of heat used,—silver requiring a higher temperature to smelt it than gold does. Most of the silver ores contain sufficient lead to make the addition of that metal superfluous ; and in

this case the ore should be treated as a lead ore. The desideratum in this assay is to produce but little lead, and obtain all the silver. If the ores are rich in silver, a portion of litharge, made of acetate of lead (sugar of lead) should be added. The quantity of litharge may be optional, but should always be in an inverse proportion to that contained in the ore. It is not necessary to have so large a quantity of silver ore as would be required of gold ore in these operations: one ounce may be considered in all cases a sufficient quantity for obtaining practical results. If the ore contains much silex, lime, or other impurities, which cannot be removed by washing, a large quantity of litharge will be required.

When the ore has been washed and finely pounded, it should be mixed, as the case may be, with more or less litharge; in some cases it will not require any. An addition of half an ounce of black flux should be made, which will produce half an ounce of lead. The powder of charcoal made of hard wood is better than black flux; one part will make thirty parts of lead, reduced from the oxide. Eight grains of charcoal will make two hundred and forty grains, or half an ounce of lead. In every instance, a half ounce or one ounce of dried borax should be added to the mass, which should be thrown loosely into a dry crucible, and not more than one third fill it. A layer of common salt should be spread over the ore, the crucible covered and

then exposed to heat. The heat should be strong and rapid. Litharge and glass of borax should finish such an assay. Boiling should be avoided in this case more than in any other; and if it cannot be entirely prevented, it should be diminished as much as possible.

If the silver ore is a perfect sulphuret, that is, if all the metals in it are sulphurets, the assay may be made comparatively easy. When this is the case, the crude ore should be finely pulverized and mixed with an equal weight of litharge, and nearly have its weight of nitre (saltpetre). If there is a large proportion of iron or copper pyrites in the ore, the amount of litharge and saltpetre should be proportionally increased. Iron pyrites require four times the above weight of nitre; copper, three times that amount. This mixture will produce all the silver in but a small quantity of lead. If the alloy contains too much saltpetre, it will not produce any lead at all; but this evil may be remedied by adding some small chips of metallic lead to the fluid mass. Any ore will readily yield its silver on the liberal addition of litharge.

Smelting Furnace.—For common experimenting purposes, an ordinary stove will give sufficient heat, if the face-bars can be shut, or, at least, partially closed. This may be done by the use of common clay. The grate may then be filled in with brick at both ends, so as to reduce the interior to one foot in length. The space above

the grate, which commonly furnishes the draft, may be closed by a sheet-iron door, or filled up with brick, leaving only a small opening for supplying the fuel and inserting the crucible. Such a grate, an iron poker, a pair of tongs, crucibles, ore, and fluxes are the only requisites for the performance of successful operations.

Black Flux. — Two parts of crude tartar (argal) and one part of saltpetre should be finely powdered and mixed together, and then gradually heated in an iron pot so as to burn it. When sufficiently warm, kindle it by means of a hot coal, when it will burn slowly, but will not melt. This mass is again finely pulverized and sifted, and is then ready for use. It should be kept in a close bottle to prevent its absorbing moisture.

Litharge. — To obtain pure litharge, take acetate of lead and dry it by a strong heat, constantly stirring it to prevent it from melting.

Galena. — This mineral, which is so often associated with silver, is of a lead-gray color, and usually of a bright metallic appearance. It is very easily broken, and usually breaks up into small, square blocks. It is very heavy, soft, and easily melted. Pure specimens contain 86.6 per cent. of lead. This is the commonest of all the ores of lead. This is the sulphide of lead. The carbonate is white or yellow, and is also very heavy and soft.

Pyrites, — which is found so often connected

with gold, is a sulphide of iron, of a yellow color, sometimes much resembling yellow copper ore. It it not, however, difficult to distinguish between them, as the copper ore is easily scratched with a hard, sharp point, while the iron pyrites is too hard to be scratched. It contains 53.3 per cent of sulpher and 46.7 of iron when pure.

Varieties of Silver.— Besides the metal itself, which may be easily known by its color and toughness, several ores of silver are known,— such as the gray, black, light-red, dark-red, and horn silver. The sulphuret of silver is the commonest of these ores. It is in the form of crystals, hairs and needles, or like wire twisted into nets; also in plates and in shapeless masses. This ore is opaque, or of a dark-gray color. Horn silver (chloride of silver) is not so generally found as the sulphuret, but appears in almost every place where silver is found. It is a horny substance, so soft as to be cut by the finger-nail. Its color is often gray; but it sometimes shows all the colors of mother-of-pearl. These colors darken if the ore is exposed to light for sometime. It is also found of a uniform green color. Antimonial is the richest of silver ores. It is of a white or yellowish-blue color, hard, and very brittle.

GLOSSARY OF TECHNICAL TERMS.

Amygdaloid—a variety of trap rock, containing nodules, agates, &c.
Ankerite, or *bitter spar*—a carbonate of lime, with magnesia, iron, and manganese.
Antimony—a brittle metal, of a silvery color, with a tinge of blue.
Arenaceous—containing sand, or consisting principally of sand.
Argentiferous—containing silver.
Argillaceous—containing clay, or of a clayey nature.
Arsenieurets—a combination of arsenic with a metallic or other base.
Augite—a greenish mineral, consisting of silica, magnesia, and lime.
Auriferous—containing gold
Back of a lode—the upper part or outcrop of a lode
Blende—a metallic ore; sulphuret of zinc.
Barytes, or *heavy spar*—white, yellow, very heavy.
Basalt—much like greenstone, of a grey or brown color, very heavy.
Branches—small veins in connection with the principal lode.
Breccia—a rock made up of angular fragments of other rocks.
Calciferous—containing carbonate of lime.
Carbonate of iron—not so rich as either of the oxides.
Carbonate of lead—white or yellow, very heavy and very soft.
Chloride—a compound of chlorine with another element.
Chlorite—quite soft, of a green color, found in thin plates, like mica, or in earthy masses.
Dolomite—a variety of magnesian carbonate of lime, occurring crystalized as rhomboidal bitter spar.
Dyke—a course or vein of igneous rock.
Epidote—a crystalized, massive, and granular mineral, variously colored, containing silica, alumina, lime, and iron.
Feldspathic—consisting of feldspar.
Ferruginous—containing iron.
Fluor—a fluate of lime.
Feldspar—a common siliceous mineral, which forms a constituent part of granite and sienite.
Greenstone—feldspar combined with hornblende.
Graywacke—a conglomerate or sandstone of a grayish color.
Galena—the most common ore of lead.
Gangue—the veinstuff in which the ores of metals occur.
Gneiss—a foliated rock, composed of quartz, feldspar, and mica, differing from granite in these minerals being in distinct layers.
Hematite—red and brown hematite are valuable ores of iron.

Hornblende—is a dark green mineral, sometimes of a brown, gray, or blue tint, rather heavy, tough, and difficult to break.
Horse—a piece of country between a wide lode, two branches of a lode being called a horse of ground; also, a boulder in the vein.
Hydrous or *hydrated*—containing water.
Igneous—unstratified rock, volcanic and plutonic, the first lava, pumice, &c., the other granite and porphyry, formed at great depths, and pushed up through the stratified rocks.
Laminated—consisting of thin plates or layers.
Manganese—a grayish white metal, brittle, appearing like cast-iron.
Mispeckel—arsenical iron pyrites, arsenic, sulpur, and iron.
Molybdena—a common sulphuret of molybdena.
Malachite—green copper ore, often mixed with a blue carbonate.
Manganese—a hard, grey metal, much like iron.
Matrix—the substance in which any ore occurs embedded.
Metalliferous—containing or yielding metal or ore.
Metallurgy—the art of extracting metals from their ores.
Metamorphic rocks—stratified rocks, disturbed from their original position, and altered in appearance where they come in contact with igneous or unstratified rocks.
Mica—a common mineral, sometimes white, often brown.
Mica schist—quartz and mica, the two minerals arranged in layers.
Mineral-bearing rocks—for definitions, see pages 12, 13.
Micaceous—containing mica, or occurring in scales like mica.
Ochre—earthy ores of iron, generally red, yellow, or brown.
Pyrites—sulphide of iron, resembling yellow copper ore, but unlike it in being too hard to be scratched with a knife.
Pyritous—containing pyrites.
Plumbago—carburet of iron; black lead.
Pockets, or *bunch*—a rich deposit of ore in a small space.
Polybasite—an iron black sulphuret of silver, copper, arsenic, and antimony.
Quartz—a very abundant hard mineral substance.
Quartzose—containing or consisting chiefly of quartz.
Red copper ore—an oxide, quite brittle and easily powdered.
Serpentine—a red or green substance, often curiously veined or mottled, smooth or greasy, and soft enough to be readily cut.
Shales—indurated clay, splitting in plates parallel to each other.
Stephanite—a valuable ore of silver; black silver.
Sulphuret—a sulphide.
Sulphides—compounds of sulphur and another element.
Talc—a soft, soapy, magnesian mineral, greenish, whitish, or grayish.
Talcose—resembling talc.
Tellurium—a rare silver-white substance, generally combined with various metals.
Trachyte—a variety of lava, essentially composed of glassy feldspar, sometimes containing hornblende.

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